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The scientific publications of the National Museum include two series, known, respectively, as *Proceedings* and *Bulletin.*

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The dates at which these separate papers are published are recorded in the tables of contents of each of the volumes.

The present volume is the hundred and seventh of this series.

The *Bulletin*, the first of which was issued in 1875, consists of a series of separate publications comprising monographs of large zoological groups and other general systematic treatises (occasionally in several volumes), faunal works, reports of expeditions, catalogs of type specimens, special collections, and other material of similar nature. The majority of the volumes are octavo in size, but a quarto size has been adopted in a few instances in which large plates were regarded as indispensable. In the *Bulletin* series appear volumes under the heading *Contributions from the United States National Herbarium*, in octavo form, published by the National Museum since 1902, which contain papers relating to the botanical collections of the Museum.

Remington Kellogg,
Director, United States National Museum.

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PROCEEDINGS OF THE UNITED STATES NATIONAL MUSEUM

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A NEW SPECIES OF MYSIDOPSIS (CRUSTACEA: MYSIDACEA) FROM THE SOUTHEASTERN COAST OF THE UNITED STATES

By Thomas E. Bowman

Until now, only one species of *Mysidopsis*, *M. bigelowi* W. Tattersall (1926), has been recorded from the Atlantic coast of the United States. This species occurs in shallow water from New England to Louisiana, commonly in association with *Metamysidopsis munda* (Zimmer) (W. Tattersall, 1951, p. 142). *Mysidopsis mortenseni* W. Tattersall (1951) was reported from St. Croix, Virgin Islands, and may yet be found in Atlantic coastal waters. Of the remaining twelve species, three are European (Tattersall and Tattersall, 1951); four are known from the southwestern and southern coasts of Africa (Zimmer, 1912; O. Tattersall, 1955); two were reported from the coasts of California and Peru (W. Tattersall, 1932; Coifmann, 1937); two were taken in Indian waters (W. Tattersall, 1922); and one is known from South Georgia, the Falkland Islands, and the adjacent coast of South America (Hansen, 1913; O. Tattersall, 1955).

Mysidopsis furca, new species

Figures 1, 2

Description.—Body slender. Carapace produced anteriorly into bluntly triangular rostrum; anterolateral angles squared; posterior

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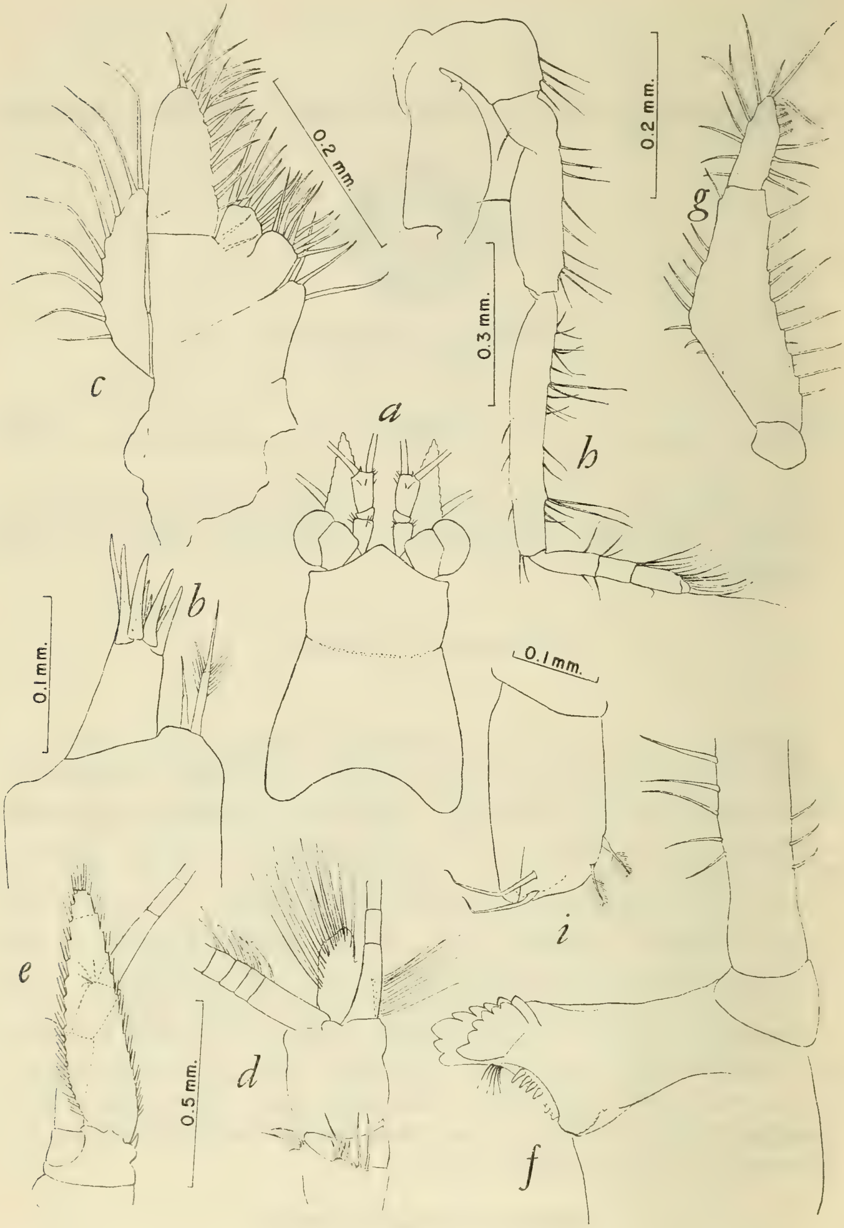

FIGURE 1.—*Mysidopsis furca*, new species: *a*, Anterior end, dorsal view, female; *b*, first maxilla, female; *c*, second maxilla, female; *d*, antenna 1, male; *e*, antenna 2, female; *f*, mandible, female; *g*, mandibular palp, female; *h*, fifth thoracic leg, female; *i*, genital appendage, male. *b* and *f*, same scale; *d* and *e*, same scale.

margin emarginate, leaving last two thoracic somites exposed in dorsal view. ABDOMEN tapering very gradually posteriorly, in lateral view usually sigmoid in female, straight or curved downward in single curve in male; first five somites subequal, sixth somite about 1.7 times as long as fifth. EYES rather large, extending beyond lateral margins of carapace; no process on dorsal surface of eyestalk. Peduncle of FIRST ANTENNA more robust in male than in female; male lobe very hirsute, with indentation on medial margin. Scale of SECOND ANTENNA about four times as long as wide, lanceolate, setose all around, with a short distal segment separated by an incomplete suture. MANDIBLE with molar process reduced to a rounded knob bearing a number of minute, blunt setae; incisor process of right mandible with eight teeth, lacinia with six teeth; incisor process of left mandible with nine teeth, lacinia with six teeth; spine row with six spines, the two nearest the molar process shorter and separated from the others. FIRST MAXILLA: Outer plate with eight spines at tip; inner plate bearing two setae, the inner one much longer. SECOND MAXILLA typical for the genus. FIRST THORACIC LEG (maxilliped) with short and stout endopod segments, very similar to that of *M. bigelowi* W. Tattersall. Endopod of SECOND THORACIC LEG stout; fifth segment 1.6 times as long as sixth; seventh segment about half as long as sixth, ending in a strong claw longer than the segment. Endopods of REMAINING LEGS characteristic for the genus. PLEOPODS of male with quadrangular lobes at the bases of the endopods; each lobe bearing five spines, four of them with bulbous bases; exopod of fourth pleopod as long as endopod, ending in a very strong spine. GENITAL APPENDAGE of male eighth thoracic leg blunt, subquadrangular, armed at the tip with two long naked setae and two shorter, more slender, plumose setae. UROPOD: Outer ramus five times as long as broad; outer margin straight; inner margin convex. Inner ramus five-sixths as long as outer ramus, tapering distally; inner margin armed with 35–40 longer and shorter spines from the level of the statocyst nearly to the distal end. TELSON very distinctive, especially in female. In female it is slightly longer than wide, bearing about 10 short spines on the concave lateral margin; distal end bearing two pairs of long, heavy spines, the outer pair curved inward, the inner pair straight, about half the length of the telson. Distal end with shallow concavity between the inner pair of spines. Male telson three-fourths as wide as long; lateral margins less concave than in female; inner pair of distal spines only about one-fifth the length of the telson; outer pair about half as long as inner pair.

LENGTH.—Measured from tip of rostrum to end of distal spines of telson: Females, 4.6–5.8 mm.; males, 4.7–6.1 mm.

COLOR.—In preserved specimens pigment is absent from the dorsal surface except for a single pair of chromatophores at the base of the

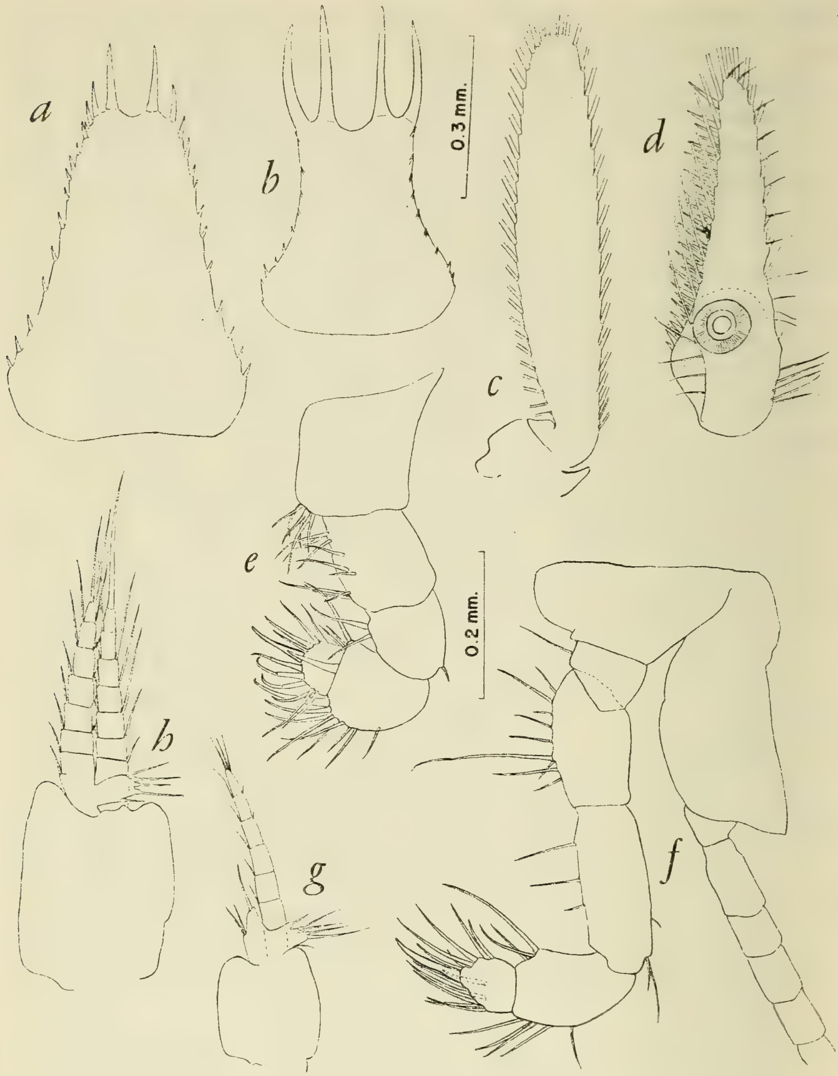

FIGURE 2.—*Mysidopsis furca*, new species: *a*, Telson, male; *b*, telson, female; *c*, outer ramus of uropod, female; *d*, inner ramus of uropod, female; *e*, first thoracic leg (maxilliped), female; *f*, second thoracic leg, female; *g*, first pleopod, male; *h*, fourth pleopod, male. *a–d*, *g–h*, same scale; *e–f*, same scale.

telson. One chromatophore is present on the midventral surface of each of the first five abdominal somites. On the ventral surface of the thorax are two pairs, and a single median chromatophore lies anterior to them. A single chromatophore is present on the base of each posterior oostegite.

Types.—Holotype, female with fully developed oostegites, 5.6 mm. in length, USNM 99219; allotype, male, 6.1 mm., USNM 99220; and 21 paratypes, all from *Theodore N. Gill* cruise 2, station 57, 33°33.7′ N., 78°24.6′ W., off North Inlet, S. C., May 8, 1953, depth of water, 20.1 meters.

Remarks.—*M. furca* can readily be distinguished from other species of *Mysidopsis* by the shape and armature of the telson. In some of the other species of *Mysidopsis* the apical spines are abruptly longer than the lateral spines, but in none of them except *M. acuta* is the inner uropod armed with spines along most of the length of its inner margin. *M. bigelowi* has only five spines in the region of the statocyst and further differs from *M. furca* in the very robust second thoracic legs. In *M. kempi* W. Tattersall, from the Gulf of Manar, the inner margin of the inner uropod has 10 spines, all in the region of the statocyst. *M. didelphys* (Norman) has one long spine near the statocyst. The telson of *M. acuta* is about twice as long as wide, and the scale of the second antenna is very narrow (about five times as long as broad) and sharply pointed.

In none of the other species of *Mysidopsis* are the apical spines of the telson as strongly developed as in the female *M. furca*. The sexual dimorphism of the telson found in the new species is most unusual, and, to my knowledge, unique among mysids.

The specific name is taken from the Latin noun, "furca," a pitchfork, and refers to the appearance of the female telson.

The following key, taken mostly from the literature, is offered here with the hope that it will facilitate identification of specimens of *Mysidopsis*.

Key to the species of *Mysidopsis*

1. Inner margin of inner uropod bearing none or a few (1–10) spines limited to the region of the statocyst 2
   Inner margin of inner uropod with many (24–75) closely packed spines extending along much of the margin 8
2. Distal spines of telson abruptly longer than lateral spines 3
   Distal spines of telson as long as or only slightly longer than lateral spines. 4
3. Inner uropod with 5 spines on inner margin; second thoracic leg strongly developed . . . . **bigelowi** W. Tattersall
   Inner uropod with 10 spines on inner margin; second thoracic leg normally developed . . . . **kempi** W. Tattersall

4. Inner uropod without spines on inner margin . . . . . **inermis** Coifmann
Inner margin of inner uropod with one spine on inner margin 5
Inner uropod with 5 spines on inner margin; carapace with 2 humps on dorsal surface 7
5. Telson about 1.1 times as long as wide; 2 spines on each lateral margin. **indica** W. Tattersall
Telson 1.4–1.6 times as long as wide; 8–20 spines on each lateral margin . 6
6. Apex of telson truncate . . . . **didelphys** (Norman)
Apex of telson with small V-shaped notch . . . . **angusta** Sars
7. Dorsal part of first abdominal somite produced posteriorly into a broad, rounded process . . . . **camelina** O. Tattersall
Dorsal part of first abdominal somite not produced posteriorly . **gibbosa** Sars
8. Distal spines of telson abruptly longer than lateral spines 9
Distal spines of telson as long as or only slightly longer than lateral spines. 10
9. Distal spines of female telson about half as long as telson. **furca**, new species
Distal spines of telson about one-eighth as long as telson . . **acuta** Hansen
10. Scale of second antenna lanceolate, 6.5–9 times as long as wide 11
Scale of second antenna oval, about 3.5 times as long as wide 13
11. Rostrum very short, broadly rounded . . . . . **californica** W. Tattersall
Rostrum pointed 12
12. Spines of inner endopod more spaced, reaching to apex; rostrum not reaching distal end of first segment of peduncle of antenna 2 . **schultzei** (Zimmer)
Spines of inner uropod very dense, extending along about seven-eighths of its total length. Rostrum acute, reaching distal end of first segment of peduncle of antenna 2 . . . . **major** (Zimmer)
13. Spines of inner endopod usually extending only to about middle of endopod; telson nearly twice as long as wide . . . . **similis** (Zimmer)
Spines of inner endopod extend nearly to distal end; telson about 1.5 times as long as wide . . . . **mortenseni** W. Tattersall

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PROCEEDINGS OF THE UNITED STATES NATIONAL MUSEUM

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RHYNOBRISSUS CUNEUS, A NEW ECHINOID FROM NORTH CAROLINA

By C. Wythe Cooke

The U. S. National Museum has recently received, as accession No. 201,828, two lots of a spatangoid echinoid collected by Miss Maureen Downey at Fort Macon Beach, near Beaufort, N. C. The first lot consists of two small and one larger nearly perfect yellowish individuals; the other, found about Jan. 15, 1956, includes fragments of one small and three larger white tests. Most of the specimens retain some of the spines. This species is particularly interesting because it represents a very rare genus known in collections by only a few individuals and now reported for the first time from the Atlantic Ocean.

Order Spatangoida L. Agassiz, 1840

Family Spatangidae Gray, 1825

Genus *Rhynobrissus* A. Agassiz, 1872

Rhynobrissus A. Agassiz, Bull. Mus. Comp. Zool., vol. 3, p. 58, 1872; Mem. Mus. Comp. Zool., vol. 3, p. 590, 1873.—H. L. Clark, Mem. Mus. Comp. Zool., vol. 46, p. 213, 1917; Carnegie Inst. Washington Publ. 566, p. 373, 1946.

Rhinobrissus A. Agassiz. Pomel, Classification méthodique et genera des échinides, p. 33, 1883.—Duncan, Journ. Linnean Soc. London, Zool., vol. 23, p. 246, 1889.—Lambert and Thiéry, Essai de nomenclature raisonnée des échinides, fasc. 6, p. 491, 1924.—Mortensen, Monograph of the Echinoidea, vol. 5, pt. 2, p. 486, 1951.

Type species: *Rhynobrissus pyramidalis* A. Agassiz, 1872, from China, by monotypy. Agassiz (1873, p. 590, pl. 23a, figs. 4–6) shows excellent photographs, somewhat reduced, of the top, bottom, and side of the type but does not figure the posterior end; the anal and subanal fascioles are shown only in profile. According to his description the anal fasciole is not connected with the subanal fasciole, and it extends some distance above the anal system. The posterior end of the test slopes backward to such an extent that the subanal plastron projects beyond the periproct.

The genus has been reviewed in Mortensen's "Monograph of the Echinoidea." Besides the type species, there are three species from the Pacific. Of these, *Rhynobrissus placopetalus* A. Agassiz and H. L. Clark, from the Hawaiian Islands, is suspected by Mortensen to be merely the young of *R. pyramidalis*. Little is known about *Rhynobrissus macropetalus* H. L. Clark, from West Australia, which seems to be difficult to distinguish from *R. pyramidalis*. *Rhynobrissus hemiasteroides* A. Agassiz, from Tahiti, the Hawaiian Islands, and Australia, is easily distinguishable from other species by its anterior apex.

A young echinoid from Cuba, originally named *Rhynobrissus micrasteroides* by A. Agassiz, later became the type of *Neopneustes* Duncan (1889).

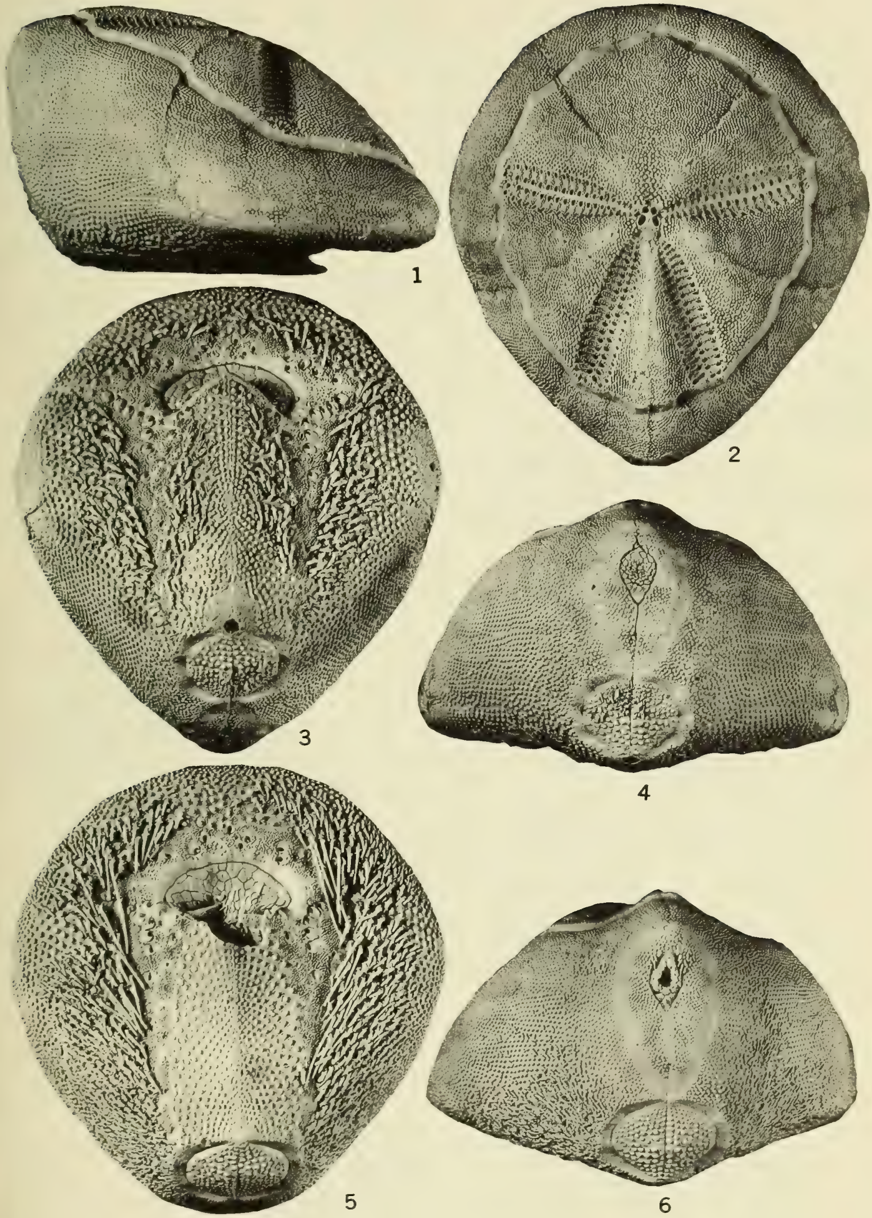
Rhynobrissus cuneus **Cooke, new species**

Plate 1

Description.—The horizontal outline is ovate, rounded in front, widest at the midline, bluntly pointed behind. The longitudinal outline is wedge-shaped (whence the specific name *cuneus*, a wedge), with the base line nearly flat; the profile of the upper surface is slightly arched, the highest point near the posterior end, thence steeply sloping forward to the acutely rounded ambitus; the profile of the posterior end is gently convex, slightly overhanging. The transverse outline is nearly semicircular, convex above.

The nearly central apical system is ethmolytic, i. e., the madreporite extends between and beyond the posterior ocular plates. The mature test has four large genital pores, the anterior pair circular and close together, the posterior pair larger, oval, diverging. One young test has only three genital pores.

The anterior ambulacrum is flush, not petaloid, the pores small, far apart, and inconspicuous. The paired ambulacra have rather long, nearly equal, straight, sunken petals, the anterior pair widely separated, diverging at an angle of approximately 137°. The posterior petals are much closer together, diverging at an angle of approximately 39°. The poriferous zones are wider than the interporiferous zones, with oval, conjugate pores.



Rhynobrissus cuneus, new species. 1–4, Holotype, USNM E–8032: 1, right side; 2, top; 3, bottom; 4, posterior end. 5, 6, Paratype, USNM E–8033: 5, bottom; 6, posterior end. All × 1½.

The posterior paired interambulacra do not reach the peristome. The odd interambulacrum includes a straight-sided amphisternous plastron extending from the labrum to the posterior truncation, where it adjoins a circular subanal plastron surrounded by the subanal fasciole. The anal fasciole touches the subanal fasciole; and it extends upward and nearly encloses the periproct in a vertically elongated ellipse, which is not quite closed at the top. The area within the anal fasciole and around the periproct differs little in decoration from that outside the fasciole.

A weakly scalloped elliptical peripetalous fasciole touches the ends of the petals.

The strongly reniform peristome is covered by many movable plates. The mouth is arched over by the projecting, bluntly pointed labrum. The phyllodes are conspicuous.

The bilunate or pyriform periproct is set high up on the narrow posterior end of the test and is covered with movable plates.

A granulation of small, close-set tubercles covers the entire upper surface except the peripetalous fasciole. The granulation extends down over the sides, but the ambulacra on the lower surface are bare. The tubercles on the plastrons are somewhat larger.

Most of the surface is covered with long, hairlike, silky spines, many of which have flat, spatulate ends.

The dimensions of the holotype are: Length, 37 mm.; width, 37 mm.; height, 23.5 mm. A smaller test measures 25 by 25.3 by 15.5 mm.

Occurrence.—Cast up by the waves at Fort Macon Beach, N. C.

Type.—U. S. National Museum E–8032; paratype, E–8033.

Comparisons.—The horizontal outline of this species is similar to that of *Rhynobrissus pyramidalis*, but the petals are proportionately longer. The two species are markedly different in vertical profile, the posterior end of the Chinese species sloping backward, whereas that of the American species is nearly vertical, even slightly overhanging. This difference in slope is caused by the much shorter, nearly equilateral lower surface of *R. cuneus*.

According to Agassiz (1873, p. 592), the anal fasciole of *Rhynobrissus pyramidalis* begins immediately above the subanal plastron but is not connected with it. In *R. cuneus* the two fascioles are in contact and separate the anal area from the subanal plastron.

The sloping upper surface and wedgelike shape distinguish *Rhynobrissus cuneus* from *R. hemiasteroides* as figured by Mortensen (1951, p. 490, pl. 28, figs. 3, 4, 7–9, 13, 14). The upper surface in *R. hemiasteroides* is almost flat in vertical profile. Mortensen's figure 13 also shows a wide separation between the anal fasciole and the subanal fasciole, which are in contact in *R. cuneus*.

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FORMOSAN COSSONINE WEEVILS OF BAMBOO [1] (COLEOPTERA: CURCULIONIDAE: COSSONINAE)

By Elwood C. Zimmerman [2]

Miss Rose Ella Warner, of the U. S. Department of Agriculture, Entomology Research Branch, Washington, D. C., has asked me to study and report upon a collection of weevils assembled by K. S. Kung, of the College of Agriculture, Taichung, Taiwan (Formosa). Mr. Kung reports that these weevils are "pests of the sheath of bamboo (*Bambusa stenostachyta* Hackel) which is usually used to pack the banana for export. . . ."

In the collection sent for study there are five species, two of them new to science. Some of these insects have become widely distributed, and they are all liable to be spread far and wide by commerce and may become pests in various localities. The specimens on which this paper is based are in the U. S. National Museum (USNM), except as noted.

[1] Research for this paper was completed at the British Museum (Natural History) during the tenure of a grant from the National Science Foundation. The author expresses gratitude to the Foundation and to the Museum.

[2] British Museum (Natural History), London, England.

The five species sent from Formosa are *Rhinanisus bambusae* Zimmerman, *Pseudostenotrupis orientalis* Zimmerman, *Pseudocossonus planatus* (Marshall), *Conarthrus ferruginineus* (Wollaston), and *C. cylindricus* Wollaston. These species may be distinguished by the following key:

1. Antennal funicle 5-segmented (length, excluding head and rostrum, 2-2.5 mm.)
Rhinanisus bambusae Zimmerman, new species
Antennal funicle 7-segmented (length, less than 2 mm. to more than 4 mm.) . 2
2. Very small, slender species, length (excluding head and rostrum) less than 2 mm.; antennal scape reaching only to about middle of eye; postocular constriction of head strongly marked on sides, head narrowed behind and in front of the constriction; fore tibiae rather evenly arcuate on dorsal edge.
Pseudostenotrupis orientalis, new species
Medium sized species, longer than 4 mm.; antennal scape reaching to or passing hind margins of eyes; postocular constriction of head moderate or slight, head broader behind the constriction than in front of it; dorsal margin of fore tibia sinuous 3
3. Dorsally flattened species; fourth tarsal segment transversely convex beneath and broadest distad; rostrum comparatively slender, obviously longer than head, lateral outlines as viewed from above obviously sinuous.
Pseudocossonus planatus (Marshall)
Subtubular species, convex above; fourth tarsal segment transversely flattened or concave basad beneath and wider basad than distad; rostrum heavy, stout, nearly straight on sides, only about as long as head 4
4. A bicolored species, basically reddish brown, with elytra darker apically and head and rostrum darker; scutellum only slightly tilted; striae 9 and 10 above fifth ventrite appearing to occupy the same depression, the interval between them rather indistinct or not well formed.
Conarthrus ferrugineus (Wollaston)
A black or nearly black species; scutellum slanting strongly downward and forward; striae 9 and 10 remaining distinct and separate above fifth ventrite, the interval between them distinct, convex and well formed.
Conarthrus cylindricus Wollaston

Genus *Rhinanisus* Broun, 1883

Rhinanisus Broun, New Zealand Journ. Sci., vol. 1, p. 489, 1883.

Fifteen or more species of this genus have been reported from New Zealand, and about six species are listed from Central and South America. It remains to be determined if the two groups of species are congeneric.

Rhinanisus bambusae, new species

FIGURES 1,*b*; 2,*b*

Color: Reddish chestnut brown, variably somewhat darker apically on pronotum, eyes black; derm moderately shiny (when clean).

Head with all setae minute and inconspicuous; length from fore edge of pronotum to front of an eye (measured from side, not from above) not as long as distance across eyes (ratio, measured from front, 11:12 or 11:13); postocular constriction subcontiguous to

posteroventro corner of eye, but rapidly diverging from eye dorsad and rather broadly and distinctly impressed across dorsum; area posterior to the constriction reticulate, almost impunctate and contrasting with the closely punctured interocular area, the sculpture of which is continuous with that of rostrum, the punctures mostly slightly closer to each other than distances between them; interocular area subequal in breadth to length of an eye; eyes not round, the posterodorsal contour flattened; underside transversely wrinkled.

Rostrum evenly arcuate with contour flattened basad to interocular area, three-fifths as long as pronotum (measured from side), sides as seen from above, narrowed from eyes to a point above the "false scrobe" behind point of antennal insertions, thence slightly roundly expanded above antennal insertions, thence evenly expanded to apex which is a little broader than interocular area; antennae inserted at one-third the length from base, scrobe strongly formed, the upper margin abrupt and strong, its posterior end contiguous with lower margin of eye, a short "false scrobe" above and behind antennal insertion; ventral surface strongly bisulcate and further substrigate; two long, stiff setae at base of oral cavity, but setae short behind that point.

Antenna with scape strongly clavate, extending back to middle of eye, about as long as funicle plus nearly one-third of club; first funicular segment as long as third plus fourth, second about as broad as long, a little longer than third, the third, fourth, and fifth each somewhat shorter and broader; club about as long as the preceding four funicular segments combined.

Prothorax shaped as illustrated, four-fifths as broad as long, broadest at about basal third; subapical constriction well marked on sides, shallowly continued across dorsum; setae not evident; reticulate microsculpture conspicuous, rather coarse; punctures on disc medium sized, mostly closer to each other than diameters of punctures.

Scutellum well developed; bare; microsculpture fine.

Elytra shaped as illustrated, more than twice (60:25) as long as pronotum; setae, except for some short ones on declivity, not, or hardly, discernible; outer (tenth) stria complete, striae 1–3 continued to elytral apex, 4 and 5 ending on the declivital callus, 6–8 coalescing at the apex of the callus and thence running as a common stria to apex; intervals 1–4 and 9 moderately costate on declivity and running to apex, the others not reaching elytral apical margin; striae evidently mostly as broad or broader than intervals on disc, their punctures close, somewhat larger than those on pronotum; intervals each with a row of small punctures.

Legs with fore femora when extended forward reaching to a point below anterior edges of eyes, middle femora when extended backward

reaching a point midway between middle parts of midcoxa and hind coxa, hind femora reaching to two-thirds the length of second ventrite; tibiae rather rapidly expanding from base to apex, uncus well developed, mucro moderate but conspicuous in adequate light; third tarsal segment (as seen with fourth removed) deeply emarginate and bilobed, ventral setae very long.

Sternum with prosternum twice as long in front of coxae as behind coxae; distance between fore coxae subequal to breadth of a coxa;

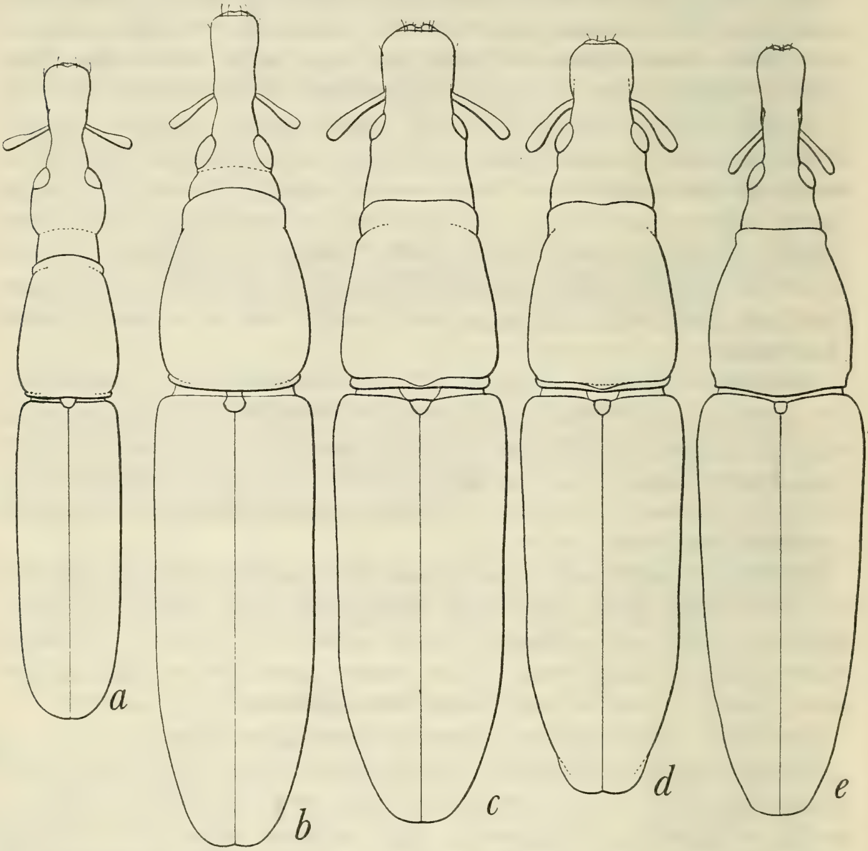

FIGURE 1.—Outlines of some Formosan Cossoninae. Length, excluding head: *a, Pseudostenotrupis orientalis* Zimmerman, holotype male, 1.5 mm.; *b, Rhinanisus bambusae* Zimmerman, allotype female, 2.2 mm.; *c, Conarthrus cylindricus* Wollaston, female, 4.5 mm.; *d, Conarthrus ferrugineus* (Wollaston), male 4.2 mm.; *e, Pseudocossonus planatus* (Marshall), male, 4.3 mm. Not to same scale.

derm rather irregularly roughened or wrinkled and punctures not, or only a few, individually evident; anterior margin truncate, subapical constriction impressed across venter, posterior margin arcuate, area in front of coxae with short setae; mesosternum continuous with

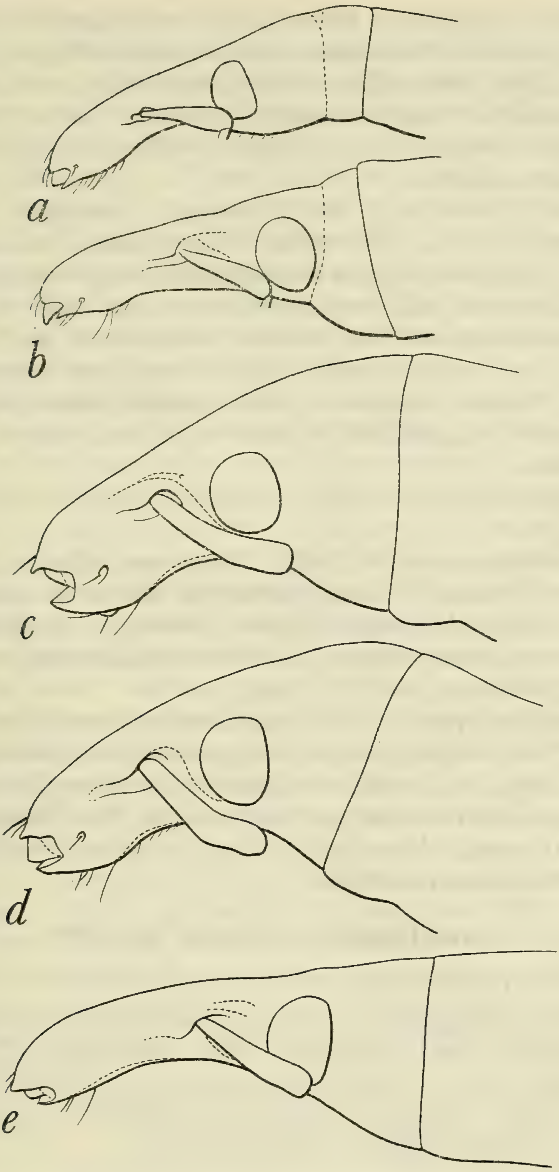

FIGURE 2.—Outlines of lateral views of head of: *a*, *Pseudostenotrupis orientalis* Zimmerman; *b*, *Rhinanisus bambusae* Zimmerman; *c*, *Conarthrus cylindricus* Wollaston; *d*, *Conarthrus ferrugineus* (Wollaston); *e*, *Pseudocossonus planatus* (Marshall). Drawings are from same specimens used in figure 1. Not to same scale. All drawings by Arthur Smith.

metasternum, mesocoxae a little farther apart than fore coxae, and equal in separation to hind coxae; metasternum subequal to length of prosternum along median line, a little longer along median line than length of ventrites 1 plus 2, broadly, shallowly concave on sides to accommodate movement of midfemora; with scattered small punctures bearing small setae.

Venter with ventrites 1 and 2 strongly coalesced, the suture hardly evident in middle, the combined length along median line equal to length of ventrites 3–5 plus 4 and 5 again, sculpture and vestiture as on metasternum, and broadly impressed on sides at middle to accommodate action of hind femora; ventrites 3 and 4 together as long as 5, each with a basal row of strong punctures and a subapical row of setae; ventrite 5 with a similar basal row of strong punctures and the apical half or more with long, erect setae arising from punctures.

Length (excluding head and rostrum), 2.1–2.5 mm.; breadth, 0.5–0.6 mm.

Types: Holotype male (USNM 63219) and allotype female are in the U. S. National Museum; paratypes are in the same museum and in the British Museum (Natural History). Described from a series of 13 specimens collected in 1955 from *Bambusa stenostachyta* at Taichung, Formosa, by K. S. Kung.

This is the first species of *Rhinanisus* to be recorded in the Pacific outside of New Zealand, where the genus is well developed. The absence of long, fine, decumbent hairs at the sides of the pronotum will alone separate the new species from the New Zealand species. The external sexual characters are poorly defined, and the determination of the sexes is difficult.

Genus *Pseudostenotrupis* Voss, 1939

Pseudostenotrupis Voss, Rev. Zool. Bot. Africaines, vol. 32, No. 1, p. 75, 1939.

Voss erected this genus to include *Proëces macer* Boheman, 1838, from Madagascar, and *Leurostenus filum* Marshall, 1933, from the Belgian Congo. Later in 1939, Voss described a third species, *parvulus*, from East Africa. He did not designate a type for the genus. *Leurostenus filum* Marshall may be taken as type.

Pseudostenotrupis orientalis, new species

FIGURES 1,*a*; 2,*a*

Color: Reddish chestnut brown, darker across front of head, base of rostrum, sternum, and first ventrite; eyes black; derm moderately shiny; all setae on dorsum very small and inconspicuous.

Head subequal in length from anterior edge of pronotum to front of an eye (measured from side) as breadth across eyes; postocular

constriction very strong on sides, but only slightly or not impressed across dorsum (when viewed from side), distinctly impressed across underside, the constriction about twice the length of an eye behind the eyes, and two-thirds the distance from hind edges of eyes to pronotum (as viewed from above); area posterior of constriction coarsely reticulate but not punctate, head otherwise reticulate and with moderately large punctures which are mostly closer to each other than the diameters of the punctures; eyes moderately interrupting lateral outline of head, distance across them slightly less than maximum breadth of crown which is at about two-thirds length from eyes to postocular constriction, interocular area one-half as broad as greatest postocular breadth of crown.

Rostrum with sculpture similar to that of interocular area, length (measured from side from anterior edge of an eye) about one-fifth longer than side of head in female, slightly less in male, gently arcuate, contour between front of head to before antennae gently, slightly concave; sides strongly narrowed from eyes to antennal insertions, over which the sides are arcuately expanded, thence rapidly expanded to apex, this expansion less strong in female, greatest subapical breadth about equal to interocular distance plus breadth of one eye in male, but only slightly broader than interocular area in female; ventrolateral apical corners drawn out into prominent processes which project beneath mandibles; ventral surface with numerous erect setae, the pre-oral ones longer than the breadth of apex of antennal scape; margins of scrobes well defined, upper margin apically contiguous with lower ocular margin; ventromedian line cariniform behind antennae.

Antennae inserted slightly behind middle of rostrum; scape reaching middle of eye, as long as funicle plus nearly one-half of club; first funicular segment as long as next three segments combined, subequal in breadth to segment 7, and appearing nearly twice as broad as segment 2; segment 2 hardly or not longer than segment 3; segments 2–7 each successively broader; club as long as preceding five funicular segments combined.

Prothorax shaped as illustrated, somewhat more than five-sevenths as broad as long, broadest just before basal third; subapical constriction, although conspicuous, not very strong, subequal in development to subbasal constriction, not impressed across dorsum; longitudinal dorsal contour, as viewed from side, nearly straight from base to apex; microsculpture of dorsum fine; punctures medium-sized, ovate, mostly separated from each other by more than their diameters on disc.

Scutellum bare, shiny.

Elytra shaped as illustrated, a little more than twice as long as pronotum to nearly 2½ times as long; outer (tenth) stria complete, but

punctures not evident in it for most of its length, strial punctures elsewhere broader than intervals, stria 1 joining stria 10, 2 joining 9, 3 joining 8, 4–7 thus ending on declivity and enclosed by the others; intervals flat, none elevated on declivity; striae and intervals difficult to trace without removal of elytra and study in fluid.

Legs with fore femora capable of reaching forward to or somewhat beyond postocular constriction, middle femora when extended backward to a point nearly midway between middle parts of midcoxa and hind coxa, hind femora when extended backward reaching to middle of second ventrite, all femora sublenticular in shape; tibiae arcuate on outer sides, uncus moderate, mucro small; third tarsal segment apically C-emarginate, ventral setae very long.

Sternum with prosternum twice as long in front of coxae as behind coxae, distance between fore coxae subequal to breadth of a fore coxa, subapical constriction crossing sternum as a narrow groove about as far behind anterior margin as three-fourths the breadth of the intercoxal distance, the punctures scattered and farther apart than their diameters; mesosternum continuous with metasternum, intercoxal process about 1½ times as broad as that between fore coxae; metasternum with scattered punctures mostly separated by distances equal to or greater than diameters of punctures, closer laterad and with setae more conspicuous there, metacoxae a little less widely separated than mesocoxae, length along median line subequal to prosternum and first three ventrites.

Venter with the suture between the first and second ventrites nearly obliterated, length of the two segments along median line equal to remaining three ventrites plus segment 5 again, the first two segments with scattered setiferous punctures, flattened down middle and with longer, overlapping hairs in this flattened area in male, this specialized zone absent in female; ventrites 3 and 4 with setiferous punctures over most of their surfaces, the two ventrites together subequal in length to ventrite 5; ventrite 5 rather closely punctate over-all, the punctures bearing moderately long, fine hairs, convex in female, but with a large, rounded, median impression in male.

Length (excluding head and rostrum), 1.4–1.5 mm.; breadth, 0.35–0.4 mm.

Types: Holotype male (USNM 63220) and allotype female in the U. S. National Museum; paratypes are in the same museum and the British Museum (Natural History). Described from a series of 38 specimens collected in 1955 from *Bambusa stenostachta* at Taichung, Formosa, by K. S. Kung.

This species somewhat resembles *Pseudostenotrupis filum* (Marshall) from the Belgian Congo, but it is smaller, more shiny, the pronotum, head, and rostrum are less densely punctate, the subapical constriction of the prothorax is less well developed, the antennal scape extends only to about the middle of the eye instead of to the hind margin as it does in *filum*, and there are other similar differences of specific importance.

Genus *Pseudocossonus* Wollaston, 1873

Pseudocossonus Wollaston, Trans. Ent. Soc. London, p. 27, 1873.
Catolethromorphus Wollaston, Trans. Ent. Soc. London, pp. 479, 563, 1873. (New synonym.)

Wollaston erected *Catolethromorphus* for a single example from the East Indies (without precise locality) which he named *nigripes*. I am unable to separate this example generically from the type of *Pseudocossonus* (*brevitarsis* Wollaston, cited by Marshall, Ent. Monthly Mag., vol. 90, p. 232, 1954), and I believe that *Catolethromorphus* should fall as a new synonym of *Pseudocossonus*, and *nigripes* may be known as *Pseudocossonus nigripes* (Wollaston), new combination.

The Formosan collection contains the following representative of the genus.

Pseudocossonus planatus (Marshall)

FIGURES 1,*e*; 2,*e*

Eutornus planatus Marshall, Arb. Morph. Tax. Ent., Berlin-Dahlem, vol. 5, No. 2, p. 161, 1938.
Oxydema planatus (Marshall) Voss, Beitr. Ent., vol. 1, No. 1, p. 88, 1951.
Pseudocossonus planatus Marshall, Ent. Monthly Mag., vol. 90, p. 232, 1954; Zimmerman, The Entomologist, vol. 89, p. 59, 1956 (synonymy).
Pseudocossonus planatus (Marshall) Zimmerman, The Entomologist, vol. 89, p. 59, 1956.

By a lapsus, Marshall described this species twice and placed it in two genera, and he gave the species the same specific name in each description. His first description was based upon material from Annam. His second description was of specimens bred from bamboo in Formosa by K. S. Kung. There is also in the British Museum a series of specimens, under *Eutornus planatus*, taken in Japan from bamboo which had been imported from Formosa. A series of specimens is in the present collection.

Marshall (Ent. Monthly Mag., vol. 90, p. 232, 1954) reviewed *Pseudocossonus*, cited *brevitarsis* as the type, and gave a key to the four species recognized by him. Following is a revised key to the five species recognized here.

Key to the species of *Pseudocossonus*

1. Basal margin of elytra slightly elevated to form a basal carina from scutellum to fourth or fifth intervals (scutellum in unique holotype concave). Japan. **brachypus** Wollaston
   Base of elytra without such a carina (scutellum convex on all examples seen) 2
2. Dorsum transversely convex or very slightly flattened and/or punctures on sides of prothorax not or hardly larger and not much if any denser than those on disc of pronotum 3
   Dorsum obviously somewhat flattened and punctures on sides of prothorax obviously much larger and denser than those on disc of pronotum (examine area above and behind coxae, especially) 4
3. Microsculpture of pronotum obvious, the reticulations regular and distinct under moderate magnification; lateral outline of prothorax obviously arcuate from base to apex and no part of contour straight; subapical constriction of prothorax broad and shallow on sides. Japan. **brevitarsis** Wollaston
   Microsculpture of pronotum extremely fine, visible only under high magnification and even then it is vague and indefinite on disc; lateral margins of pronotum with contour nearly straight in middle region, although gently converging cephalad, the subapical constriction strong and sharply indented on sides. New Guinea . . . . **dimidiatus** Wollaston
4. Hind angles of pronotum strongly, conspicuously, abruptly, angulately emarginate, thus forming a shoulder which fits under elytra; subapical constriction of pronotum strongly formed and sharply indenting sides of pronotum; "East Indies" . . . . **nigripes** (Wollaston)
   Subbasal constriction of pronotum feeble and shallow; subapical constriction, although strong, roundly instead of sharply indenting sides of pronotum; Formosa, Japan. . . . . **planatus** (Marshall)

Genus *Conarthrus* Wollaston, 1873

Conarthrus Wollaston, Trans. Ent. Soc. London, pp. 491, 577, 1873; Zimmerman, The Entomologist, vol. 89, p. 56, 1956 (synonymy).
Eutornus Wollaston, Trans. Ent. Soc. London, pp. 492, 578, 1873; not Clark, Catalogue of Halticidae in the . . . British Museum . . . , pt, 1, p. 64, 1860.
Eutornicus Marshall, Ann. Mag. Nat. Hist., vol. 13, No. 98, p. 97, 1946.

Two species of *Conarthrus* are represented in the Formosan collection now at hand, but it is probable that other species occur on Formosa.

Conarthrus ferrugineus (Wollaston)

Figures 1,*d*; 2,*d*

Eutornus ferrugineus Wollaston, Trans. Ent. Soc. London, p. 638, 1873.
Conarthrus ferrugineus (Wollaston) Zimmerman, The Entomologist, vol. 89, p. 58, 1956.
Eutornus congener Wollaston, Cist. Ent., vol. 1, p. 206, 1874; Zimmerman, The Entomologist, vol. 89, p. 58, 1956 (synonymy).

In addition to the numerous specimens in the present collection from Formosa, I have examined material in the British Museum from

Burma, Assam, Tonkin, Sumatra, Java, Borneo, Malacca, Makian, Gilolo, Tondano, Morty, and New Guinea.

Conarthrus cylindricus **Wollaston**

FIGURES 1,*c*; 2,*c*

Conarthrus cylindricus Wollaston, Trans. Ent. Soc. London, p. 637, 1873; Zimmerman, The Entomologist, vol. 89, p. 57, 1956 (synonymy).
Conarthrus vicinus Wollaston, Trans. Ent. Soc. London, p. 637, 1873.
Eutornus jansoni Wollaston, Trans. Ent. Soc. London, p. 637, 1873.

In addition to the few Formosan specimens collected by Mr. Kung, there are others in the British Museum that were taken from bamboo in Cochin China and others that were intercepted at Gisborne, New Zealand, in "bamboo strips used for packing jute mats imported from India." The species is known also from Ceylon and from Bachan in the Moluccus. It is variable and widespread.

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SOME LITTORAL BARNACLES FROM THE TUAMOTU, MARSHALL, AND CAROLINE ISLANDS[1]

By Dora Priaulx Henry

A small number of barnacles collected by the Pacific Science Board expeditions at three localities—Ngarumaoa Island, Tuamotu Islands; South Loi Island, Marshall Islands; and Ifaluk Atoll, Caroline Islands—was sent to the author for identification. In all, there are seven species: three from the Caroline Islands, one from the Marshall Islands, and four, including one new species, from the Tuamotu Islands. In addition, a few barnacles collected by the *Albatross* at Makemo, Tuamotu Islands, were borrowed from the U. S. National Museum (USNM) to compare with the new material. Although the collection is small, it is of considerable interest as nothing is known of the barnacles of these islands except for *Lithotrya nicobarica* Reinhardt, which was reported from Makemo as *Lithotrya pacifica* Borradaile by Pilsbry (1907). The collection from Ngarumaoa Island contains *Lithotrya nicobarica* Reinhardt, *Lithotrya valentiana* (Gray), *Verruca cookei* Pilsbry, previously known from the Hawaiian Islands, and a new species of *Chthamalus*, which is of special interest as it is the first member of the genus to possess a true calcareous basis. A few small specimens of this species were also found on *Lithotrya nicobarica* from

[1] Contribution No. 210 from the Department of Oceanography, University of Washington, Seattle, Wash.

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Makemo. The one species from the Marshall Islands is *Tetraclita pacifica* Pilsbry, originally described by Pilsbry (1928) as *Tetraclita wireni pacifica* from Necker and Wake Islands. The barnacles from the Carolines are *Chthamalus hembeli* (Conrad), *Tetraclita squamosa squamosa* (Bruguière), and *Lithrotrya nicobarica* Reinhardt.

Genus *Lithotrya* Sowerby, 1822 [2]

Sewell (1926), after a detailed study of a large number of specimens of *Lithotrya nicobarica*, lists all the known species and subspecies of *Lithotrya* except *L. dorsalis*, *L. truncata*, *L. valentiana*, and *L. rhodiopus* as synonyms of *L. nicobarica* Reinhardt. However, at the end of his paper, he states that it is his belief that *L. dorsalis* and *L. nicobarica* cannot be differentiated. Nilsson-Cantell (1933) compared *L. dorsalis* from Bonaire and various museums with *L. nicobarica* from several localities, and he believes that these two species are distinct. Cannon (1935) has shown that *L. truncata* is a synonym of *L. valentiana*. *L. rhodiopus* is known only from Darwin's (1851) description of imperfect specimens so that its position is still doubtful. The valid species in the genus *Lithotrya* are, therefore, *L. dorsalis*, *L. nicobarica*, *L. valentiana*, and possibly *L. rhodiopus*.

Lithotrya nicobarica Reinhardt

Lithotrya nicobarica Reinhardt, 1850, p. 1, pl. 1, figs. 1–3.—Darwin, 1851, p. 359, pl. 8, fig. 2.—Gruvel, 1905, p. 99.—Hoek, 1907, p. 122, pl. 9, fig. 9.—Annandale, 1916, p. 131, pl. 7, fig. 2.—Nilsson-Cantell, 1921, p. 219; 1934a, p. 45.—Sewell, 1926, pp. 269–300, 18 figs., pls. 14, 15.—Hiro, 1937, p. 44.

Lithotrya cauta Darwin, 1851, p. 356, pl. 8, fig. 3.

Lithotrya pacifica Borradaile, 1900, p. 798, pl. 51, figs. 3, 3a.—Hoek, 1907, p. 126, pl. 9, figs. 13, 13a, 14.—Pilsbry, 1907, p. 6.

Lithotrya dorsalis var. *maldivensis* Borradaile, 1903, p. 441.

Lithotrya dorsalis var. *rugata* Borradaile, 1903, p. 441.

Lithotrya conica Hoek, 1907, p. 124, pl. 9, figs. 10–12.

Localities.—Ngarumaoa Island, Raroia Atoll, Tuamotu Islands; collected by J. P. E. Morrison, July 11, 1952, on outer reef flats, with *Chthamalus calcareobasis* and *Verruca cookei* (11 specimens, USNM 96480).

Makemo, Tuamotu Islands; collected by the *Albatross*, Oct. 21 1899, on the reef, with *Chthamalus calcareobasis* (7 specimens, USNM, 32885).

South end of Falarik Island, Ifaluk Atoll, Caroline Islands; collected by F. M. Bayer, Oct. 22, 1953, dug out of large rock just inside high reef (2 specimens, USNM 99341).

[2] For synonymy, see Darwin (1851, p. 332).

Remarks: Several of the specimens are larger than the largest (greatest carinorostral diameter of the capitulum, 11.5 mm.) examined by Sewell (1926). The specimens from Ngarumaoa Island vary in carinorostral diameter from 6 mm. to 16 mm.; those from Makemo, from 11 mm. to 18 mm.; and the two from the Ifaluk Atoll, from 15 mm. to 16 mm. Externally, the specimens show most of the variations figured by Sewell. The cirri and mouthparts of a specimen with a carinorostral diameter of 18 mm. from Makemo are of special interest as the specimen was in the last stage before molting. The new long spines of the cirri are situated close to each ramus with their ends pointed distally and not "with their upper ends enclosed within the old spines, but with their lower ends projecting inwards, beyond the bases of the old spines, and inverted like the fingers of a glove hastily pulled off" as stated by Darwin (1854, p. 157). The labrum has 60 teeth. Sewell found 40 teeth on a small specimen and 42 on one of the largest, so he concluded that there is little change in the number of teeth with advancing age. The palps have rounded ends with doubly serrate spines on the ends and upper margins. In one mandible, between the first and second tooth, the new edge has 25 pectinations and the old edge has 13, some of which are broken off; between the second and third tooth the new edge has 9 pectinations and the old edge has 3. The other mandible has 19 pectinations on the new edge and 12 on the old edge between the first and second tooth, and 10 on the new edge and 8 on the old edge between the second and third tooth. There is also a greater number of pectinations on the new edge of the inferior angle than on the old edge. Sewell has pointed out that the ratio of the number of pectinations between the first and second tooth to the number between the second and third tooth is not a valid diagnostic character as the rate changes with advancing age. The number of spines in the middle group on the inner maxilla is also greater (17 instead of 10) in this specimen than in Sewell's largest specimen, although the number above the notch, in the notch, and on the inferior angle is the same. The outer maxilla has a slight notch without spines. One caudal appendage has 19 segments, the other has 11 segments. In a specimen with a carinorostral diameter of 16 mm., one caudal appendage has 27 segments and the other has 20 segments. Both specimens have five pairs of spines and seven or eight small spines between the pairs on the median segments of the sixth cirrus. Sewell found four pairs of spines and six or seven small spines in the largest specimen.

***Lithotrya valentiana* (Gray)**

Conchotrya valentiana Gray, 1825, p. 102.
Anatifa truncata Quoy and Gaimard, 1834, p. 636, pl. 93, figs. 12–15.

Lithotrya valentiana Darwin, 1851, p. 371, pl. 8, fig. 5.—Gruvel, 1902, p. 250.—Barnard, 1924, p. 48.—Cannon, 1935, pp. 1–17, 7 figs., 2 pls.—Hiro, 1937, p. 42, 1 fig.

Lithotrya truncata Darwin, 1851, p. 366, pl. 9, fig. 1.—Hoek, 1907, p. 127.—Nilsson-Cantell, 1921, p. 213, fig. 34.

Lithotrya truncata longicaudata Nilsson-Cantell, 1921, p. 216, fig. 35a.

Locality: Ngarumaoa Island, Raroia Atoll, Tuamotu Islands; collected by J. P. E. Morrison, July 8, 1952 (1 specimen, USNM 96481).

Remarks: Greatest diameter of capitulum, 5.5 mm., greatest height, 6.5 mm. Laterals wanting; one membranous filament on one side and two on the other side.

Genus *Verruca* Schumacher, 1817 [3]

Verruca cookei Pilsbry

Plate 1, figures *a–j*

Verruca cookei Pilsbry, 1928, p. 308, 2 figs., pl. 25, fig. 9.

Locality: Ngarumaoa Island, Raroia Atoll, Tuamotu Islands; collected by J. P. E. Morrison, July 11, 1952, on outer reef flats; on *Lithotrya nicobarica;* with *Chthamalus calcareobasis* (2 specimens).

Remarks: The specimens, one about 1.8 mm. in carinorostral diameter, the other 2.2 mm., were situated between two growth ridges on the scutum of *Lithotrya nicobarica* with the long (carinorostral) axis parallel to the base of the scutum. These specimens differ somewhat from the typical form. Both have the right-hand, instead of the left-hand, scutum and tergum fixed, and both are elongate in the carinorostral axis, instead of subcircular (pl. 1,*a*,*b*). In the larger specimen, the upper articular ridge of the movable scutum is about a third of the tergal margin, the second articular ridge is a little over two-thirds the tergal margin, and the third ridge extends to the base (pl. 1,*c*). Internally, the upper part of the valve is hollowed out, the tergal margin is slightly inflected in the upper part, and the occludent margin is strongly inflected (pl. 1,*b*). The movable tergum is triangular in shape instead of quadrangular as in the type; the third articular ridge is low in the upper part (pl. 1,*e*). Internally, the occludent margin is inflected (pl. 1,*d*). In the fixed scutum (pl. 1,*f*), the adductor ridge, which is narrower than in the type, extends obliquely from the base of the narrow rostral margin to the inner part of the thick tergal margin. The straight plate of the fixed tergum (pl. 1,*g*) is higher than the adductor ridge of the scutum. The rostrum (pl. 1,*i*,*j*) has three teeth on the carinal margin and seven fine ridges on the

[3] For synonymy, see Pilsbry (1916, p. 15).

upper part of the scutal margin. Plate 1,*i* also shows a crack extending from the apex of the plate to the basal margin, and a heavy deposit of calcareous material covering the crack can be seen on the inner side (pl. 1,*j*). The carina (pl. 1,*h*) has three teeth on the rostral margin and several fine ridges on the upper part of the tergal margin. In the smaller specimen, a narrow projection of the carinal margin of the rostrum fits into a furrow on a slightly broader projection of the rostral margin of the carina; the adductor ridge of the fixed scutum is very prominent.

The mouthparts and cirri agree, for the most part, with Pilsbry's description. The larger specimen, which contained eggs, has 10 segments in the caudal appendages and 5 pairs of spines on the posterior cirri. The smaller specimen has 6 segments in the caudal appendages and 5 pairs of spines on one or two segments of the sixth cirrus and 4 pairs on the rest.

Genus *Chthamalus* Ranzani

Chthamalus Pilsbry, 1916, p. 293 (synonymy).

Diagnosis: Compartments six; rostrum and carina with alae; rostrolaterals triangular, without alae, the sheath having a narrow projection. Carinolaterals wanting. Basis membranous or calcareous; sometimes membranous basis covered with a calcareous layer formed of the inflected basal edges of the compartments.

Labrum with concave or straight edge, toothed or spinose. Mandible with lower part pectinated. First two pairs of cirri short, densely spinose, the third pair much longer and bearing spines like those of the posterior cirri.

Type: *Chthamalus stellatus* (Poli).

Chthamalus hembeli (Conrad)

Euraphia hembeli Conrad, 1837, p. 261, pl. 20, fig. 13.
Chthamalus hembeli Darwin, 1854, p. 465, pl. 18, figs. 5a–5e.—Weltner, 1897, p. 272.—Gruvel, 1905, p. 205.—Pilsbry, 1916, p. 324, pl. 76; 1928, p. 310, pl. 26, fig. 6.—Nilsson-Cantell, 1921, p. 290, fig. 55.

Locality: Reef north of northwest end of Falarik Islet, Ifaluk Atoll, Caroline Islands; collected by D. P. Abbott, 1953, from big rock on outer reef flat 125 ft. in from breaker line (1 specimen, USNM 99340).

Remarks: The external surface is corroded, more or less covered with worm tubes, and the orifice is worn down. Only one suture, which shows interlocking teeth, is discernible on the exterior, but all sutures are visible on the inside. The basis is completely covered by a nonstriate calcareous layer which is continuous with the inner

lamina of the parietes. The opercular valves agree with those figured by Pilsbry (1916, pl. 76, fig. 2c) except that the articular ridge of the scutum is not as prominent.

The carinorostral diameter is 50 mm.; the height of the rostrum is 15 mm. and height of the carina, 21 mm.

The cirri and mouthparts agree with the descriptions of Pilsbry (1916) except for the labrum, which has both spines and teeth as found by Nilsson-Cantell (1921) and one mandible with 2 strong teeth and a slight thickening instead of 3 strong teeth. The dentation of the mandible is apparently variable in this species as Nilsson-Cantell (1921) figures one mandible with a small tooth between the second and third teeth.

Chthamalus calcareobasis, new species

PLATES 1,*k–n*; 2,*a–o*

TYPE SPECIMENS: Holotype, USNM 96482; paratypes, USNM 96483.

LOCALITIES: Ngarumaoa Island, Raroia Atoll, Tuamotu Islands; collected by J. P. E. Morrison, July 8, 1952, on *Tridacna maxima* on outer reef flat (3 specimens, USNM 96484); July 9, 1952, on coral patches near or on outer reef (*Lithothamnion*) ridge (about 50 specimens, USNM 96482, 96483, 96485); July 11, 1952, on outer reef flats; on *Lithotrya nicobarica*; with *Verruca cookei* (7 specimens, USNM 96480).

Makemo, Tuamotu Islands, collected by the *Albatross* Oct. 21, 1899, on the reef; on *Lithotrya nicobarica* (6 specimens, USNM 32885).

DIAGNOSIS: Distinguished from all other species of *Chthamalus* by the calcareous basis.

DESCRIPTION: Shell (pl. 2,*a*) shortly cylindric, sometimes with one or more compartments spreading, with quadrangular orifice; wall rugose or ribbed, moderately thick; epidermis not persistent. Color white or white tinged with pink or purple. Radii narrow, longitudinally striated as is the adjacent part of the adjoining compartment, summits oblique. Alae moderately wide, summits oblique. Sutures simple; disarticulated radii and alae show prominent interlocking denticles on the edges. Sheath purple or tinged with purple; inner lamina immediately below sheath purple, rest white. Basal margin of parietes (pl. 2,*b*) with several rows of teeth in shortly cylindric specimens; in spreading compartments, basal margin finely denticulate and inner lamina ridged. Basis (pl. 2,*c–f*) calcareous throughout, edge with pits or ridges (pl. 2,*c–d*), into which the denticles or ridges of the basal part of the parietes fit; flat (pl. 2,*e*) or, more usually,

irregularly elongate (pl. 2,*d*) or cupshaped (pl. 2,*f*); the depth of deepened bases may be greater than the height of the walls. Basis calcareous but thin in young specimens (carinorostral diameter about 5 mm.).

Carinorostral diameter, 24 mm.; height carina, 16 mm., rostrum, 14 mm. Carinorostral diameter, 12 mm.; height carina, 6 mm., rostrum 3 mm.; depth basis, 6 mm. Carinorostral diameter 5 mm.; height, 2.5 mm.

Opercular valves (pl. 2,*g–o*) not cemented together, lined with purplish black membrane. Scutum with basal margin about same length as tergal and shorter than occludent margin. Externally, white or white with purple splotches near tergal margin, moderate growth ridges, and, in young or noncorroded specimens, 1 to 3 shallow radial furrows, middle furrow usually deeper, may indent edge (pl. 2,*l–n*). Internally, color varying from white with purple splotches to purple with narrow white bands on the margins; tergal margin bisinuate with slightly reflexed articular ridge in the middle; adductor ridge wanting; adductor pit moderate; valve above pit usually roughened; pit with crests for lateral depressor muscle prominent; 3–4 crests for rostral depressor muscle close to occludent basal margin; occludent margin thick, alternate growth ridges forming somewhat oblique teeth on inner side.

Tergum with convex carinal margin thinner than rest of valve and a short wide spur (pl. 2,*g,i,o*). Spur united to the basiscutal margin and occupying about one-half the basal margin; longitudinal furrow wide and shallow. Externally, white or white with splotches of purple; growth ridges fine in main part of valve, wider in the spur furrow, usually obliterated on the thin carinal portion of the valve; fine longitudinal lines crenulate growth ridges in middle of valve; scutal margin inflected on the spur; crests prominent, projecting below basal margin, not denticulate. Internally, white with purple at apex and extending down the middle of valve; scutal margin with wide articular furrow below articular ridge, narrower above; articular ridge short and narrow, slightly reflexed in young and noncorroded specimens; middle part of valve roughened.

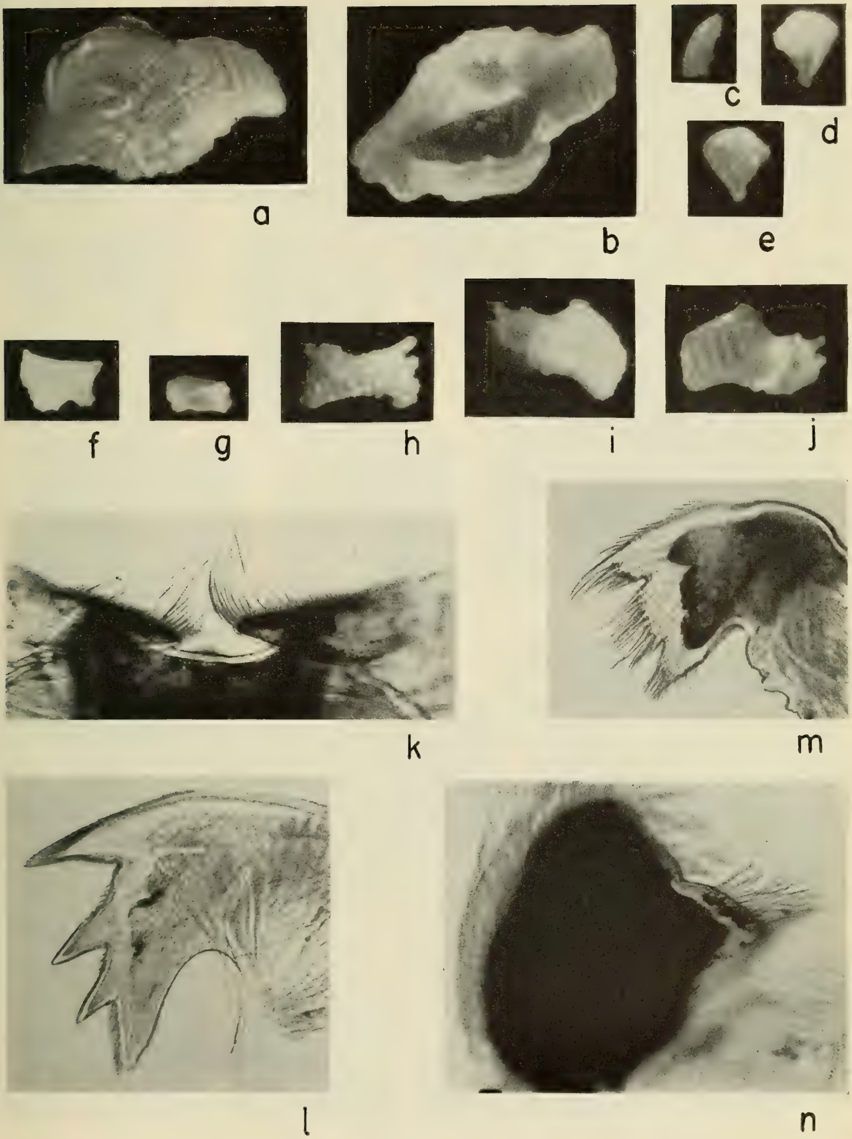
Labrum (pl. 1,*k*) with low teeth and spines along entire concave margin. Palp (pl. 1,*k*) with rounded end and pectinated spines, decreasing in size proximally, on the upper margin. Mandible (pl. 1,*l*) with three strong teeth and a lower pectinated point; pectinations between teeth; upper and lower margins spinose. First maxilla (fig. 1,*m*) with 1 large pair of spines and 7 or 8 small spines above upper notch, 7 or 8 pairs intermediate-sized spines on middle of valve, followed by a second notch and about 10 pairs of finer spines set on a

protuberance; upper and lower margins spinose. Second maxilla (pl. 1,*n*) with notch; spines absent in notch, elsewhere pectinated.

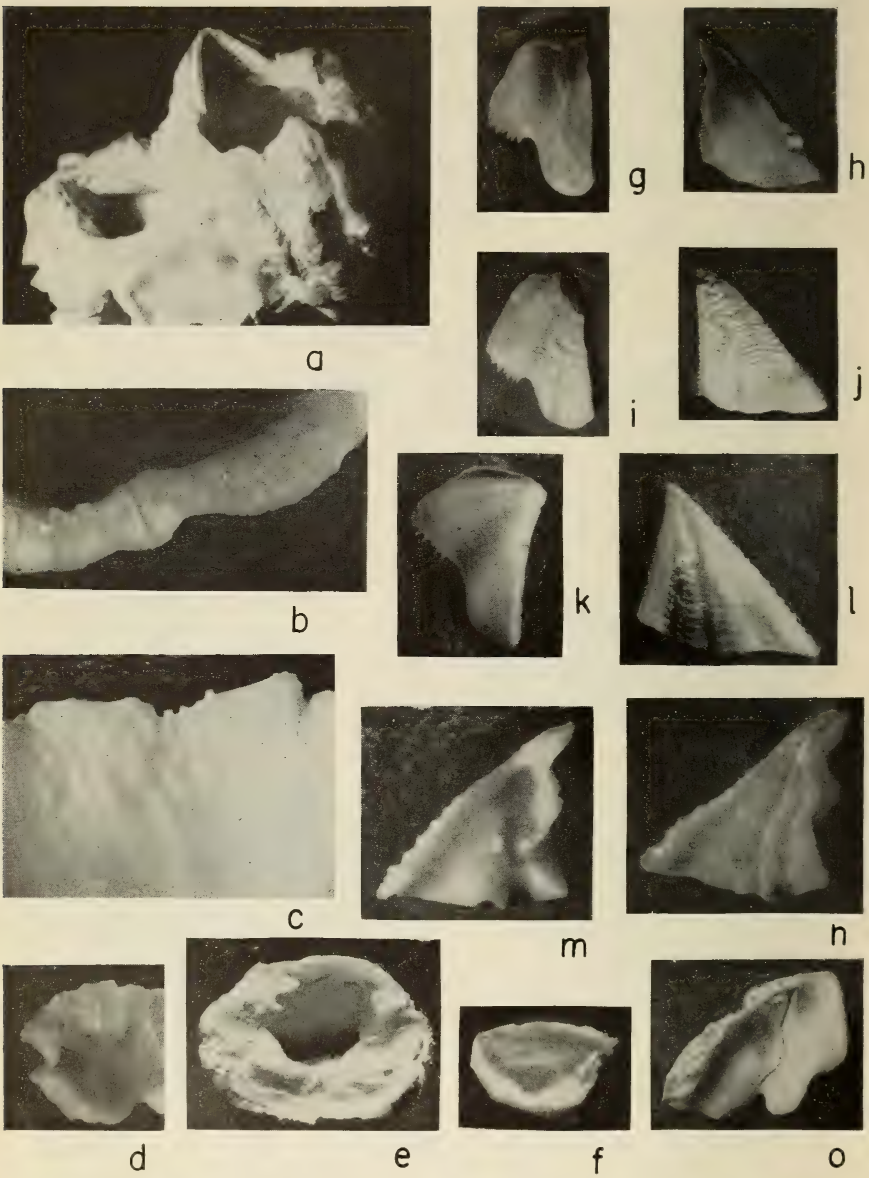
Cirrus I with 9 segments in anterior ramus, 7 in posterior; anterior, 2 segments longer than posterior; long spines pectinate on both rami, plumose on pedicel. Anterior ramus with short thick spines on the anterior and posterior borders of the basal 5 segments and similar but shorter spines on the distal sutures of all segments. Cirrus II with subequal rami of 7 and 9 segments; both rami with long pectinate spines and fine, multifid spinules on the distal sutures; anterior ramus with a few short thick spines on the posterior distal angles of the basal 3 segments. Cirrus III with subequal rami of 14 and 17 segments with 3 pairs of spines on the anterior borders and multifid spinules on the distal sutures. Posterior cirri with 3 pairs of spines and a small spine between each pair on the anterior borders, one or two long spines and several short thicker ones on the posterior distal angles, and multifid spinules on the distal sutures. Rami of cirrus IV with 18 and 19 segments, cirrus V, 20 and 17 segments, and cirrus VI, 20 and 19 segments. Penis with 2 tufts of terminal spines and a few fine spines scattered on the segments.

DISCUSSION: This species is very closely allied to *Chthamalus hembeli* (Conrad) as shown especially by the similarity of the scuta, the sutures, and the mandible. The main difference between the two species is the presence of a true calcareous basis in *C. calcareobasis*. Darwin (1854) examined five old specimens and three separated valves of a young specimen of *C. hembeli*. The old specimens had flat, wide, calcareous bases which were continuous with the inner laminae of the parietes, but in the young specimen (basal diameter about 18 mm.) he states: "there was no appearance of any tendency in the parietes thus to grow inflected." He believed that in a series of specimens some would be found with a flat narrow ledge as in *C. intertextus* and some with increasingly wider ledges until the edges met in the middle and coalesced into a continuous plate.

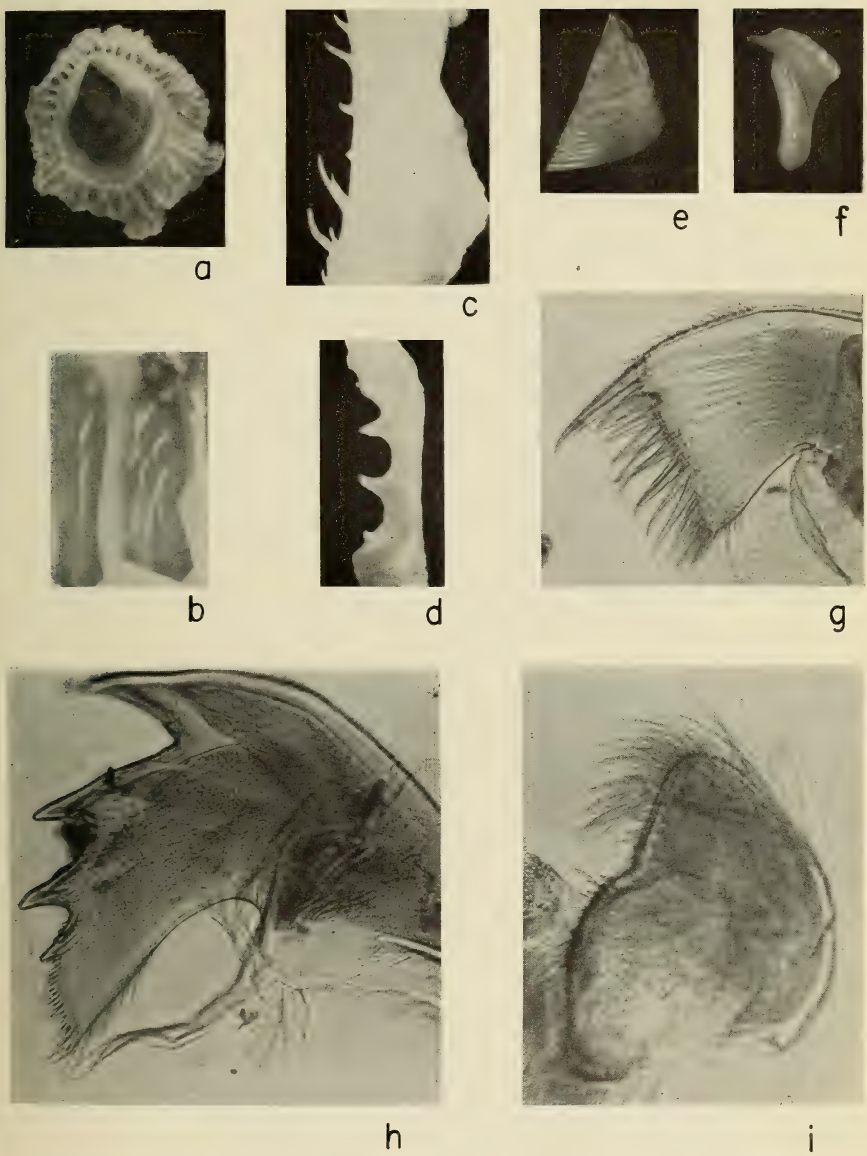
Pilsbry (1916) examined two large specimens and three opercular valves and the body of another specimen. He describes the basis as follows: " 'Basis membranous, but surrounded by a ledge formed by the inflected basal edges of the parietes,' or in old individuals the inflected edges of the compartments cover the whole base with a strong whitish calcareous layer. The false basis does not, of course, show radial furrows or lines, but is quite smooth." Pilsbry does not identify the source of his quotation, which is undoubtedly from Darwin (1854), but for another barnacle. Darwin (1854, p. 467) in the diagnosis of *C. intertextus* states: "basis membranous, but surrounded by a ledge formed by the inflected basal edges of the parietes." As seen in the paragraph above, Darwin believed that *C. hembeli* goes



a–j, *Verruca cookei* Pilsbry, × 20. *a*, Apical view; *b*, basal view, same specimen; *c*, *d*, internal views of movable scutum and tergum; *e*, external view of movable tergum; *f*, *g*, internal views of fixed scutum and tergum; *h*, external view of carina; *i*,*j*, external and internal views of rostrum. *k–n*, *Chthamalus calcareobasis*, new species, × 62. *k*, Labrum and palpi; *l*, mandible; *m*, first maxilla; *n*, second maxilla. All photographs by Eugene E. Collias.



Chthamalus calcareobasis, new species. *a*, Apical view of holotype (specimen on right side), × 2; *b*, basal view of rostrum and rostrolateral, × 10; *c*, internal view of edge of basis (shown in *d*), × 10; *d*, internal view of basis, × 2; *e*, basal view, showing part of basis, × 3; *f*, internal view of cup-shaped basis, × 2; *g–j*, internal and external views of opercular plates of holotype, × 3; *k*, *l*, external views of tergum and scutum of a young specimen, × 10; *m–n*, internal and external views of scuta of another young specimen, × 10; *o*, internal view of scutum and tergum, × 3.



Tetraclita pacifica Pilsbry. *a*, Basal view, × 2; *b*, internal view of outer lamina, × 10; *c*, lateral view of spines, × 7; *d*, longitudinal section of outer lamina, × 20; *e*, *f*, external views of scutum and tergum, × 3; *g*, first maxilla, × 62; *h*, mandible, × 62; *i*, second maxilla, × 62.

through this stage before the continuous plate found in old individuals is formed, but so far no one has seen the earlier stages in the formation of the basis. Nilsson-Cantell (1921) examined 3 specimens, one of which was only 25 mm. in diameter, but he does not mention whether this specimen had a continuous basis or not.

Another striking difference between *C. calcareobasis* and *C. hembeli* is the prominent spur on the tergum of *C. calcareobasis;* in fact, the spur is much more prominent than is usual for the genus. Further differences are found in the maxillae, palpi, and the cirri. In *C. calcareobasis* the spines of the first maxilla are differentiated by size into 3 groups and the notches are prominent, whereas, in *C. hembeli,* the spines, which are very numerous, vary much less in size and the notches are insignificant. The second maxilla of *C. calcareobasis* has a small notch without spines, but in *C. hembeli* there is no notch. The rami of the second cirrus of *C. calcareobasis* are subequal instead of very unequal as found for *C. hembeli* by both Pilsbry (1916) and Nilsson-Cantell (1921), and the sixth cirrus has 3 pairs of spines instead of 4 and does not have the bunches of short spines between the paired spines as found in *C. hembeli.*

Genus *Tetraclita* Schumacher

Tetraclita Pilsbry, 1916, p. 248 (synonymy).

Tetraclita squamosa squamosa (Bruguière)

Balanus squamosa Bruguière, 1789, p. 170.

Tetraclita porosa viridis Darwin, 1854, p. 329.—Kruger, 1911, p. 61, pl. 4, fig. 41b.—Nilsson-Cantell, 1921, p. 364; 1930, p. 17; 1931, p. 115; 1934a, p. 71; 1934b, p. 61, 1938, p. 76.

Tetraclita squamosa squamosa Pilsbry, 1916, p. 251.

Tetraclita squamosa viridis Broch, 1922, p. 337.—Hiro, 1937, p. 66, figs. 13a, 13b; 1939, p. 271.

Locality: Ifaluk Atoll, Caroline Islands; collected by F. M. Bayer, Sept. 20, 1953, on the outer reef of Ella Island (4 specimens, USNM 99342).

Tetraclita pacifica Pilsbry emend.

Plate 3,*a–i*

Tetraclita wireni pacifica Pilsbry, 1928, p. 312, pl. 26, figs. 1–5.

Locality: South Loi Island, Kwajalein Atoll, Marshall Islands; collected by F. S. McNeil, 1951–52 (11 specimens, USNM 96486).

Supplementary diagnosis: This species differs from all other species of *Tetraclita* by a combination of the following characteristics: the small number of tubes in the parietes, the presence of calcareous spines in the parietal tubes, and the inconspicuous adductor ridge of the scutum.

Supplementary description: Shell conical with small or moderately large orifice; wall finely ribbed in young, rugose and often corroded in adult. Color white or white tinged with Prussian red. Radii narrow, transversely grooved in young, inconspicuous or obliterated in adults. Sheath Prussian red, usually long; inner lamina faintly ribbed internally. Tubes in parietes arranged in a row of large quadrangular tubes, radially elongate, and a varying number of small triangular or round tubes near the outer lamina. In a specimen with a carinorostral diameter of 18 mm. (pl. 3,*a*), the number of large tubes is 11 in the rostrum, 8 in one lateral and 9 in the other, and 6 in the carina; the number of small tubes is 6 in the rostrum, 5 in one lateral and 7 in the other, and 2 in the carina. In specimens with maximum diameters of 21 mm., 26 mm., and 30 mm., some plates have a third series of tubes formed by the bifurcation of the septa of the second series of tubes. In a specimen with a carinorostral diameter of 26 mm., the number of large tubes is 12 in the rostrum, 6 in one lateral and 7 in the other, and 8 in the carina. The number of small tubes in the second series is 9 in the rostrum, 1 in one lateral and 2 in the other, and 5 in the carina. The number of tubes in the third series is 3 in the rostrum, 2 in the carina, and none in either lateral. Large tubes not filled up even at apex of shell; many of tubes with calcareous spines in 1 to 6 rows extending nearly to apex of tubes on the inside of the outer lamina and less frequently scattered on the sides of the septa and the outside of the inner lamina; small tubes occasionally with 1 to 2 rows of spines. Spines straight or curved with pointed, single or double ends (pl. 3,*b*,*c*). The spines, which are hollow, extend from the outer edge of the outer lamina to the inner edge where they project into the cavity of the tube; maximum length of free part of spine, 1.3 mm. Figure 3,*d*, a section through the outer lamina, shows the cavity in the upper spine and the surface of the spine below it. Outer lamina often ridged at base, occasionally ridges extend short way up tube; septa sometimes finely denticulate near outer lamina. The two smallest specimens with carinorostral diameters of 2.5 mm. and 6.0 mm. have a single row of tubes without spines. The next largest specimen, with a carinorostral diameter of 15 mm., has 14 secondary tubes near the outer lamina. Basis calcareous, radially ridged internally near outer edge.

Carinorostral diameter of type, 21.1 mm. Carinorostral diameter of largest specimen from the Marshall Islands, 21 mm., lateral diameter, 30 mm.; height of rostrum, 20 mm., height of carina, 10 mm.

Scutum (pl. 3,*e*) with occludent margin longer than basal. Externally, white with narrow growth ridges, alternate ones forming oblique teeth on occludent margin, faint longitudinal striations, and either a shallow longitudinal furrow or translucent area in middle of

valve. Internally, white with Prussian red at apex and sometimes extending down middle; articular ridge low, slightly reflexed, about half the length of tergal margin; articular furrow narrow; adductor ridge short, very low or represented by mere thickening of the valve; crests for lateral depressor prominent, 4 in number; crests for rostral depressor finer, more numerous.

Tergum (pl. 3,*f*) narrow, beaked. Spur narrow with rounded end, one side united with basiscutal angle and other side sloping gradually to the slightly oblique basal margin. Externally, white with shallow depression running to spur. Internally, articular ridge extremely narrow and low; articular furrow moderately wide; scutal margin slightly inflected; crests for depressor prominent.

Labrum with concave, spinose margin bearing 7 to 10 teeth. Palp concave above and convex below with rounded end; spines on end and upper margin pinnate, decreasing in length but increasing in width proximally. Mandible (pl. 3,*h*) with 4 teeth or sometimes with a rudimentary fifth tooth close to the spinate inferior angle; second and third teeth double; the smaller of each double tooth and the fourth tooth with either serrate edge or thickened edge if projections have been worn down. Lower margin of mandible spinose; upper margin with small tuft of spines. First maxilla (pl. 3,*g*) with small notch filled with small spines below upper large pair, about 7 pairs of medium-sized spines below notch, followed by small spines on lower fourth of valve; upper and lower margins spinose. Second maxilla (pl. 3,*i*) with slight notch, without spines; spines shorter above and below notch than on rest of margin.

Cirrus I with anterior ramus nearly twice as long as posterior, long spines and a few short spines on distal sutures finely pinnate on ends; pedicel with plumose spines. Cirrus II with subequal rami, spination like cirrus I. Cirrus III with very unequal rami, posterior about a third longer than anterior ramus; spines on upper segments pinnate; spines on lower segments slender and pinnate or thicker and serrate; pedicel with plumose spines on anterior borders of both segments and a tuft of plumose spines on the posterior distal angle of the lower segment. Posterior cirri with 3 pairs of spines, some pinnate, a few fine spines on the anterior border of each segment, and a tuft of short spines on the posterior distal sutures. Penis with a few spines encircling the orifice and scattered over the segments.

Number of segments in the cirri

Diameter	I	II	III	IV	V	VI
25 mm.	18, 9	10, 9	19, 24	20, 19	21, 22	23, 22
26 mm.	16, 8	9, 9	12, 21	–	–	24, 23

REMARKS: Pilsbry (1928, p. 313) states that the wall of *Tetraclita wireni pacifica* has "a single series of square or squarish tubes, in most of them some laminae and often slender spines projecting from the outer layer of the wall"; and yet his figure of the type specimen (pl. 26, fig. 1) clearly shows several small secondary tubes near the outer lamina. The specimens from the Marshall Islands also show one or two series of secondary tubes. Therefore, Pilsbry's subspecies cannot be a subspecies of *Tetraclita* (*Tesseropora*) *wireni*, which has a single row of tubes, and it is proposed to raise it to specific rank in the subgenus, *Tetraclita*, in which the wall has several rows of tubes.

Tetraclita pacifica may be considered the connecting link between these two subgenera, showing the first step in the formation of a multilayer wall; in other species of the subgenus *Tetraclita*, this stage occurs in very young individuals. The structure of the wall, with the exception of the development of secondary tubes, is very similar to that of *T. rosea* and *T. wireni*, the two species in the subgenus *Tesseropora*. The tubes in the first row are similar in size and shape to those in the single row in *T. rosea* and *T. wireni*, and calcareous spines and laminae instead of laminae alone have been developed to strengthen the outer wall.

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A NEW SPECIES OF CALANOPIA (COPEPODA: CALANOIDA) FROM THE CARIBBEAN SEA

By Thomas E. Bowman

The genus *Calanopia* (family Pontellidae) consists principally of Indo-Pacific species. Of the eight species now known, four have been reported only from Indo-Pacific localities: *C. aurivillii* Cleve, *C. herdmani* A. Scott, *C. sarsi* C. B. Wilson, and *C. thompsoni* A. Scott. *C. media* Gurney (1927) is known only from the Suez Canal. Although reported by C. B. Wilson (1950, p. 174) from *Albatross* Station 5186, off Panay Island, Philippines, *C. americana* Dahl appears to be restricted to the Atlantic Ocean. I have examined the Philippine specimens and have found them all to be *C. elliptica* (Dana).

Prior to the publication of Wilson's *Carnegie* (1942) and *Albatross* (1950) papers, *C. minor* A. Scott and *C. elliptica* (Dana) were known only from the Indo-Pacific. Wilson (1942) listed both species as present at *Albatross* Station 2396 (lat. 28°34′ N., long. 86°48′ W., Gulf of Mexico). The species of copepods in the sample from Station 2396 are entirely different from those in Wilson's list. No specimens of *Calanopia* are present in this sample, and none of the specimens of *Calanopia* in the U. S. National Museum collections were taken from this sample. Dr. Abraham Fleminger, who has made an extensive survey of the calanoid copepods of the Gulf of Mexico, informs me

(in litt. Aug. 3, 1955) that *C. americana* is the only species of *Calanopia* he has seen in plankton collections from the Gulf of Mexico.

Wilson also recorded *C. elliptica* from *Carnegie* Station 32. Examination showed these not to be *C. elliptica* but a new species, which is described below. Thompson and Scott (1903) found *C. elliptica* in samples collected in the Suez Canal and in the Mediterranean near Port Said (Station 37). Gurney (1927) did not find it in the Suez Canal, and its presence in the Mediterranean needs to be confirmed.

C. elliptica and *C. minor*, then, must be added to the list of species limited to the Indo-Pacific, while only two species, *C. americana* and the species from *Carnegie* Station 32 inhabit the Atlantic Ocean.

Illustrations of all species except *C. media* and *C. sarsi* are provided by A. Scott (1909) in his *Siboga* Expedition report. Pesta (1912) has provided a key to the females of these species.

***Calanopia biloba*, new species**

FIGURES 1–3

Calanopia elliptica (Dana), C. B. Wilson, 1942, p. 172 (Caribbean specimens only).

SPECIMENS EXAMINED: 53 females, 46 males, 10 juveniles, collected in surface plankton tow, *Carnegie* cruise No. 7, Station 32, Oct. 5, 1928. Caribbean sea, lat. 15°18′ N., long. 68°11′ W., surface temperature 28.0° C., surface salinity 35.9 ‰, bottom depth 4566 m.

TYPES: Holotype male, 1.55 mm., USNM 99506; allotype female, 1.67 mm., USNM 99507; 107 paratypes, USNM 80076.

DIAGNOSIS: Female closely resembling *C. elliptica* in most particulars, but the right and left fifth legs are of equal length (in *C. elliptica* the left leg is longer). Male urosome with two processes on right side of second segment. A conical process extends posteriad from the posterior margin; slightly anterior and dorsal to this arises an auricular process directed laterad. Fifth legs similar to those of *C. elliptica*, but left leg not reaching distal end of second segment of right leg (in *C. elliptica* left leg reaches well beyond distal end of second segment of right leg).

ADDITIONAL DESCRIPTION: FEMALE: Total length, excluding caudal setae, 1.65–1.67 mm. Metasome about 3.3 times length of urosome. Genital and anal segments nearly equal in length. Caudal rami about three-fourths as long as anal segment, more than three times as long as wide. First antenna 17-segmented, reaching back to about the middle of genital segment. Mouthparts and swimming legs 1–4 identical in number and arrangement of setae with those illustrated by Giesbrecht (1892) for *C. elliptica.*

MALE: Total length, 1.45–1.55 mm. Metasome 2.0–2.1 times length of urosome. First two segments of urosome subequal, third

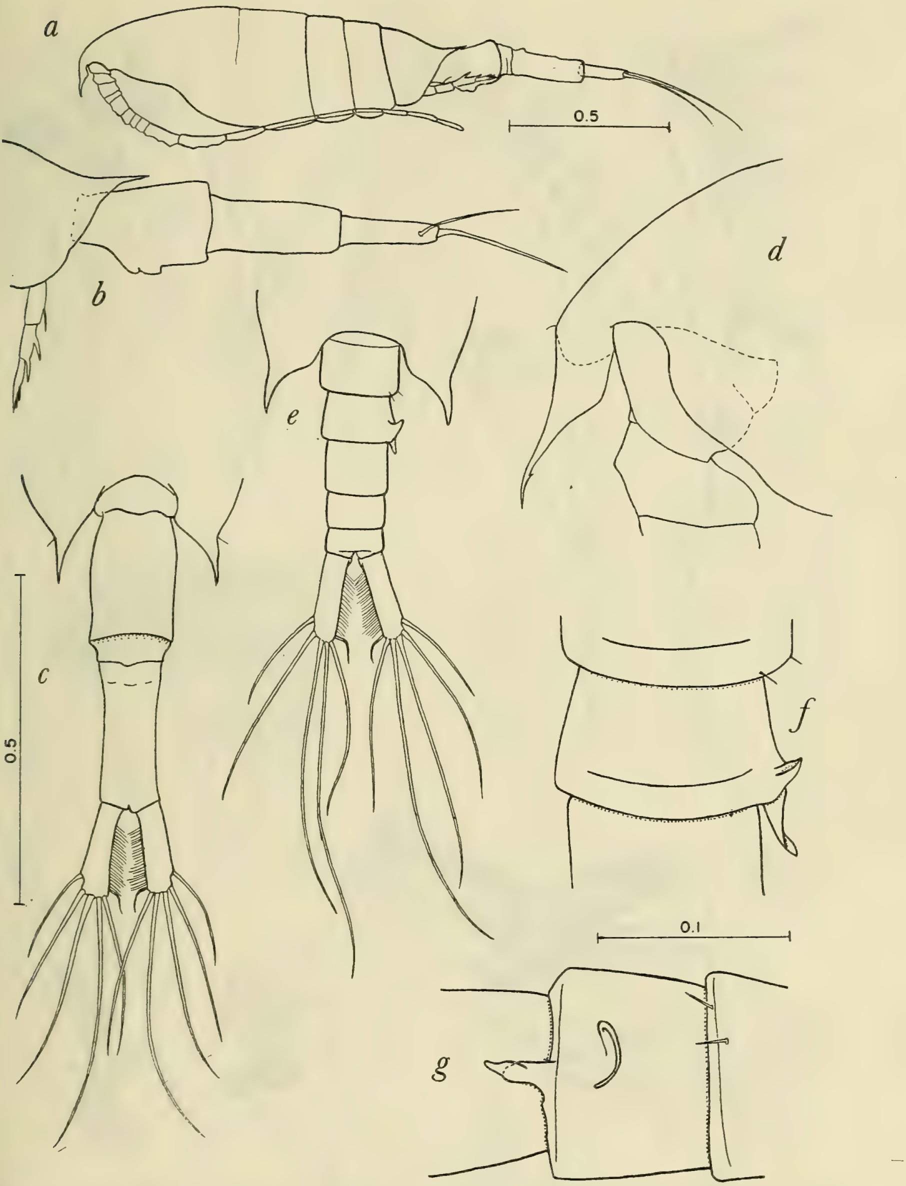

FIGURE 1.—*Calanopia biloba*, new species. *a–d*, Female: *a*, lateral view; *b*, last metasomal segment and urosome, lateral; *c*, same, dorsal; *d*, head, lateral. *e–g*, Male: *e*, last metasomal segment and urosome, dorsal; *f*, second urosomal segment, dorsal; *g*, same, from right side. Scales in mm., same for *b*, *c*, and *e*; same for *d*, *f*, and *g*.

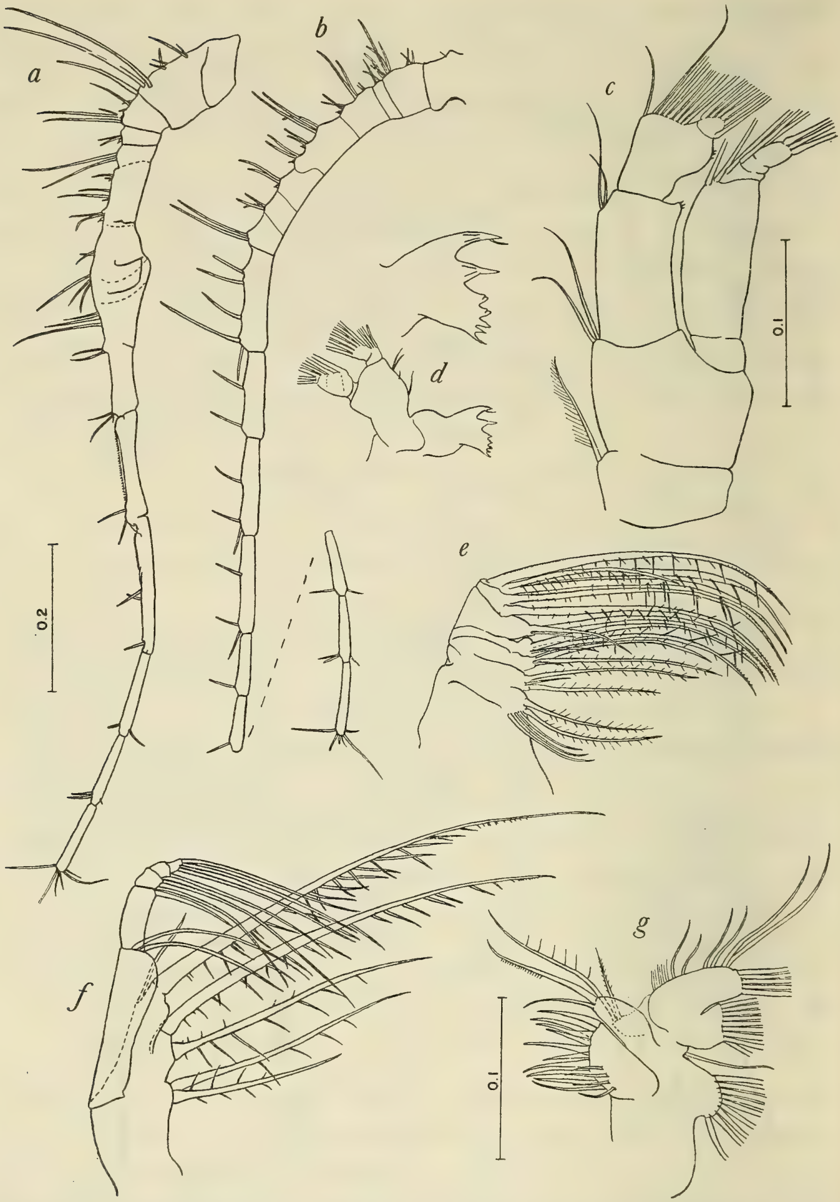

FIGURE 2.—*Calanopia biloba*, new species. *a*, Right antenna 1 of male. *b–g*, Female; *b*, antenna 1; *c*, antenna 2; *d*, mandible, with detail of gnathal lobe; *e*, maxilla 2; *f*, maxilliped; *g*, maxilla 1. Scales in mm., same for *a*, *b*, and *e*; same for *c* and *f*; and same for *d* (detail) and *g*.

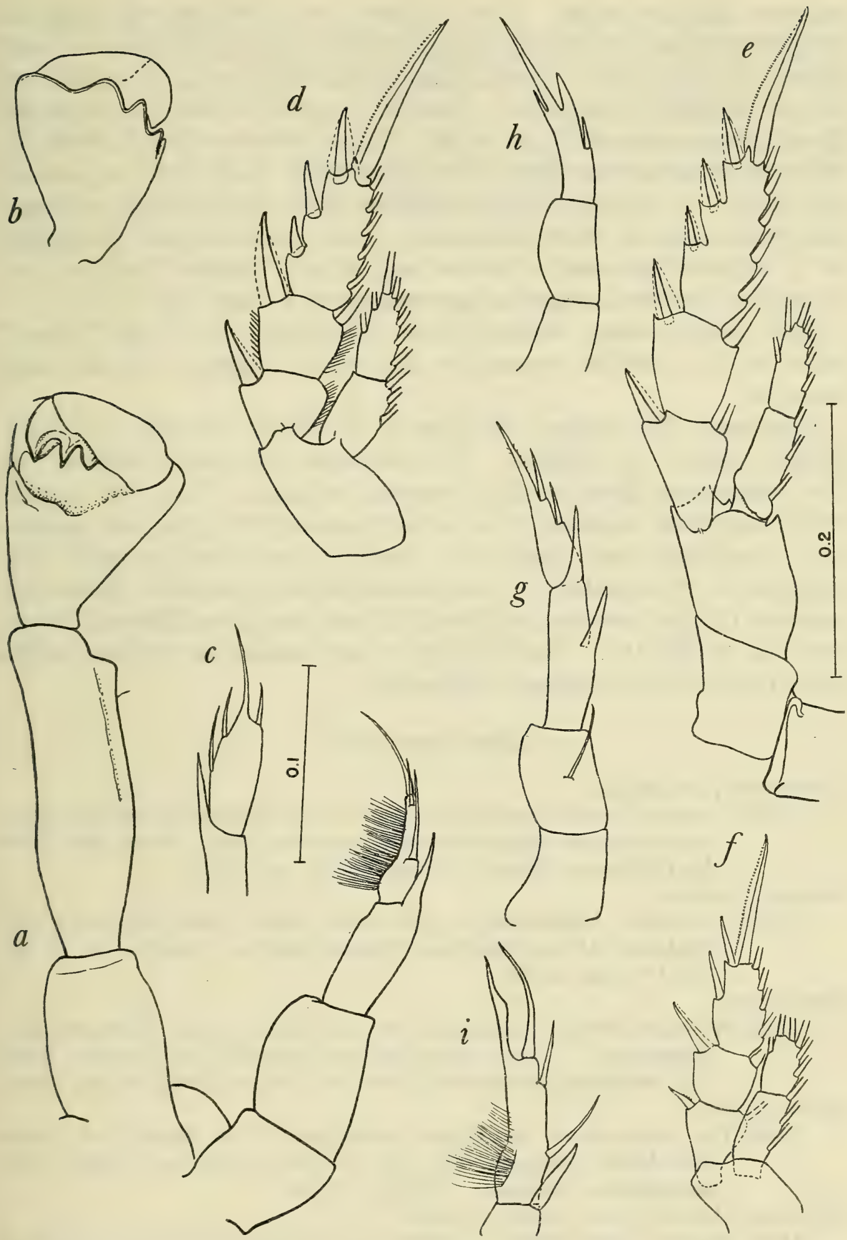

FIGURE 3.—*a–g*, *Calanopia biloba*, new species. *a–c*, Male: *a*, fifth legs, posterior surface; *b*, distal segments of right fifth leg, anterior surface; *c*, distal segment of left fifth leg. *d–g*, Female: *d*, second leg; *e*, fourth leg; *f*, first leg; *g*, fifth leg. *h*, *Calanopia americana* Dahl, fifth leg, female; *i*, *Calanopia elliptica* (Dana), distal segment of left fifth leg, male. Scales in mm., same for *a*, *b*, *c*, *g*, *h*, and *i*; same for *d*, *e*, and *f*.

segment slightly longer. First segment bearing a pair of setae on the posterior part of the right side, one of them slightly posterior and dorsal to the other. First antenna reaching back to middle of second segment of urosome. Relative lengths of last five segments (from distal end), 27,27,31,49,38. Right fifth leg like that of *C. elliptica;* opposing margins of chela toothed. Left fifth leg shorter than that of *C. elliptica;* terminal segment ends in a seta-like prolongation at the base of which is situated a thin seta about half its length; in *C. elliptica* the seta is heavier and slightly longer than the prolongation, the two having the appearance of a chela (fig. 3,*i*).

The specific name, derived from the Latin "bi-" and "lobus," refers to the double process on the second segment of the male urosome.

Remarks: The closest affinities of *C. biloba* are with its Indo-Pacific relative, *C. elliptica*. The principal differences between the two species are given in the foregoing account. The only species which might be expected to occur in company with the new species is *C. americana*, and these two Atlantic species can be easily distinguished. The male of *C. americana* has no process on the second segment of the urosome, and the fifth legs are quite different (Scott, 1909, pl. 48, fig. 15). The fifth legs of the female (fig. 3,*h*) are unlike those of any other species of *Calanopia*.

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THE FROGFISHES OF THE FAMILY ANTENNARIIDAE

By Leonard P. Schultz

In my attempt to identify fishes for inclusion in the report on "The Fishes of the Marshall and Marianas Islands," I find it impossible to place confidence in the literature describing marine reef fishes of the tropical Indo-Pacific regions unless the genus or the family in which they belong has been revised. Ichthyologists or fishery biologists who have not attempted a revision of a genus of widely ranging marine fishes cannot possibly assess the untrustworthiness of most current faunal lists. To correctly identify as to genus and to species, tropical Indo-Pacific fishes must be considered on a world-wide basis. Those few individuals who have attempted revisions of genera have found a disturbing percentage of the scientific names currently applied to be unreliable. Even a serious attempt at revision of a genus may not clarify the nomenclatorial status of more than 95 percent of the species. The doubtfully identified 5 percent results mostly from the inaccessibility to the author of those types of species preserved in the scattered museums of the world.

The problems of classification and analysis of species and genera encountered in one family are the same as found in many other families that I have studied. In general, there are three such problems.

(1) The characters used in distinguishing species or genera in each family must be carefully evaluated. Only in a general way are the characters of one family reliable for use in another family. It is important to determine for each character its variability, and what reliance can be placed on it for each genus. Frequently this cannot be established until all species have been studied in the family.

Another problem encountered is, (2) what constitutes a genus in the family being revised? Those who have studied many complex fish families know that the limits of a genus are variable. The characters

used for defining genera in one family usually do not apply equally and in the same way in a related family. The genus is partly a subjective category in taxonomy and no doubt will remain of that nature because (a) different values are attributed to distinguishing characters; (b) there is a practical need of relatively more genera in a complex family, composed of very numerous species more or less closely related, than in a less complex family; and (c) in the practice of taxonomy there is brought together under a group name few to many closely related species, which are thought to represent a phyletic line, but whether this line is to be assigned generic or subgeneric level may be decided more or less subjectively.

The characters used in establishing phyletic lines should not be confined to morphological ones. They may be physiological or involve habits and life history, such as are encountered in breeding behavior. The behavior of a species is usually reflected in its morphology. As species diverged in their evolution, the change in behavior probably preceded the morphological change; for example, artificially landlocked races of red salmon have a slower rate of growth, and when maturity is reached they are of a dwarf size. Should this change become inherited we would be dealing with a morphological step in evolution.

The evaluation of generic characters and recognition of genera is possible only when a comprehensive study is made of a family on a world-wide basis and when there is established the nature of the similarities and differences among groups of species. Sometimes fin ray counts (table 1) are useful for this purpose.

To me, a genus is a concept for distinguishing a phyletic line, and it may be represented by one or more species. When a genus includes many species, some of which are a little different from others but agree among themselves and it is difficult to comprehend or to deal with the various smaller phyletic lines, then the genus should be broken into lesser phyletic lines represented by full genera or subgenera, depending on the nature and amount of the variability. The use of subgenera, however, cannot reduce or increase the number of natural phyletic lines. If these occur, and are definable, there is little one can do but recognize them in our system of naming. Thus, it is possible to have a small family overdivided into genera or a large family underdivided into genera. Whatever is done, the nomenclature should serve as a tool for the benefit of other biological disciplines; it should serve as a means of expressing, by names, the groups of species that are closely related and in the same phyletic line.

The problem (3) of how far to progress nomenclatorially in recognizing generic categories must be resolved in a practical manner so that biologists are not presented with a confusion of ill-defined genera.

Usually this confusion and lack of agreement among ichthyologists and fishery biologists results from inadequate studies of a family. Obviously, no dependable solution is possible on how many genera and subgenera to recognize in a family until the zoological relationships of all its species have been adequately compared morphologically, physiologically, and as to habits. No doubt, after this work has been done, a middle of the road or even a conservative attitude on the number of phyletic lines to name would meet with general acceptance. Too often in ichthyology there is a tendency either to unite genera without adequate study or to establish new genera without any attempt to review the family as a whole. The least confusion results if the present status of each genus in a family is retained until such time as it is thoroughly studied.

Let us examine a few current problems as a practical application in recognizing natural phyletic lines for the basis of a genus or subgenus. According to the discussion, a group of closely related species, all of which have one or more common characteristics (morphological, physiological or life history), represents a generic category. Where one phyletic line has two or more such species but a third species differs in one or more tested characters, then I would recognize two full genera or two subgenera, depending on the amount of divergence in the characters tested. Thus, one must evaluate all characters used for each family.

The family Salmonidae illustrates the confusion and diverse thinking on problems of evaluating generic levels. Two well known groups of species are currently referred to the genus *Salmo* in Europe. One group consists of the rainbow trout *Salmo gairdneri*, cutthroat trout *S. clarki*, and Atlantic salmon *S. salar*, among others which may be omitted here. The life history of these trout are much the same; they migrate upstream to spawn in gravel riffles, returning year after year to spawn, and, normally, they do not die after spawning.

The other group of several species is known as the North Pacific salmon, referred to the genus *Oncorhynchus* by North Americans but to *Salmo* by Europeans. Although there are a few minor morphological characters that distinguish these two groups of species, all die after spawning only once. Even if there were no easily observable anatomical features, I would recognize the two distinct phyletic lines as full genera on the basis of the profound genetic differences in the two types of life history.

Another example of current interest involves morphological differences, not life histories. Morton and Miller (Copeia, No. 2, pp. 116–124, pls. 1, 2, 1954) proposed that *Cristivomer* (the lake trout) be considered a synonym of or a subgenus under *Salvelinus*. Although a genus may be originally established on a character that later proves

valueless, such a genus may be adequately distinguished at a later date on the basis of characters not even considered by the original author. That appears to be the case with *Cristivomer*. Morton and Miller have demonstrated very beautifully that *Salvelinus* and *Cristivomer* cannot be generically distinguished by the crested vomer, after which the genus was named. However, they clearly state (p. 122): "We agree with Kendall (1919) that the lake trout represents a line of development distinct from the other chars. Three characters of *Salvelinus namaycush* that are not known to overlap with those of other species of *Salvelinus* are coloration, the position of the dorsal fin and the number of pyloric caeca." In their summary (p. 123) the authors state: "A number of characters readily distinguish *S. namaycush* from all other members of the genus. The best of these, we believe, are color pattern, dorsal-fin position, the deeply forked caudal fin, and the large number of pyloric caeca." Therefore, by the authors own conclusions there are established two phyletic lines, one for *Salvelinus*, with three or more species, and another for the monotypic *Cristivomer*. The remarkably distinct color pattern between the two phyletic lines alone is sufficient to justify subgeneric categories, but with four well established characters generic rank is justified in my opinion.

One of the shortcomings of some generic changes made by authors is the lack of a comprehensive study on a world-wide basis. Actually, the evaluation of generic characters for the Salmonidae must involve Old World genera and species. Had this been done, Morton and Miller's conclusions as well as mine might have been different. This is an example of how the introduction of nomenclatorial changes without a detailed revision of the family leads to confusion.

This discussion bears on my immediate problems: (1) How shall I evaluate the characters observed for the numerous species of Antennariidae, and (2) what level of generic interpretation should I give to each phyletic line? I believe that in evaluating each important character I should consider the evolutionary trend toward its more specialized condition.

Important characters for the Antennariidae are as follows:

1. The skin varies from highly dentigerous to almost naked, and in the most naked species some embedded prickles can be detected microscopically. Naked skin is assumed to be the most specialized condition.

2. The most specialized condition of the gill filaments on the first gill arch is that of greatest reduction, where only one-half the lower part of the first gill arch bears filaments.

3. The most primitive condition of the bait or lure at the tip of the first dorsal spine may be represented by a simple filament. The next step would be the development of a tuft of filaments, followed by specialization into bifid or trifid tentacles.

4. The more numerous and most complex development of dermal cirri all over the body would represent the more specialized condition. These cirri even replace the dermal denticles in one genus.

5. Fin rays present somewhat of a problem but, in general, branched soft rays are assumed to be a more specialized condition than simple soft rays.

6. The more posterior position of the gill opening is considered to represent specialization.

7. The most movable condition of the dorsal spines should represent the more generalized condition, whereas embedded dorsal spines should represent the most specialized.

8. The distinct caudal peduncle is considered more primitive than when the median fins are membranously attached to the base of the caudal fin.

9. Adult antennariids in general have a sedentary habitat. *Histrio* has a sedentary habitat in seaweed but often the seaweed floats pelagically in the ocean. Thus, I consider *Histrio* to be more specialized in its "sedentary" pelagic habitat than the other antennariids.

Using the above characters I have prepared a diagram (fig. 1) suggesting the more important phyletic lines of evolution among the antennariids. Under each generic or subgeneric category are the abbreviations of the anatomical characters showing relationships. Definitions of the abbreviations used are given on page 52, facing figure 1.

The frogfishes, family Antennariidae, may be recognized by their globular-shaped bodies, more or less rough skin caused by minute denticles; pectoral fin limblike; gill opening restricted to a pore near or a little behind the pectoral "elbo"; first dorsal spine, if free, with "bait" or lure at its distal end; second and third spines separate, sometimes embedded or partly covered with skin; a fourth free dorsal spine, completely embedded, followed by the soft dorsal fin; caudal fin rays usually all divided, occasionally one of the outer rays may be simple, and number 4+5; gill rakers poorly developed on first gill arch; gill filaments on first arch greatly reduced on dorsal part of arch or lacking; mouth almost vertical; small conical teeth in rows on jaws, vomer, palatines, and tongue.

In general frogfishes are carnivorous, voracious, and mostly of a sedentary nature. However, *Histrio* will pursue its prey but usually

waits quietly for a fish to swim close enough in a head-on approach, then the attack occurs quickly. The victim is sucked into the big mouth of the frogfish almost instantly, at least quicker than the eye can follow. Often a fish as large as the frogfish is engulfed.

As far as known, frogfishes liberate their eggs in a single long ribbonlike gelatinous mass, which floats like a raft of logs on the way to a sawmill. This gelatinous mass is enormous in proportion to the fish that deposited it.

Before deposition the egg mass lies closely packed in the ovaries, "like a banknote tightly rolled up from its two ends."

Frogfishes have been observed by Drs. Waldo Schmitt and W. H. Longley to inflate their stomachs with air or water, which swells them into an enormous size. A few specimens in the collections of the National Museum are distended with liquid.

The following scientific names are unidentifiable:

Chironectes pavoninus Cuvier and Valenciennes, vol. 12, p. 421, 1837; *C. chlorostygma* Cuvier and Valenciennes, vol. 12, p. 426, 1837.

Lophius spectrum Gray, Catalogue of fish collected and described by Laurence Theodore Gronow, p. 49, 1854 (type locality, Antilles).

Antennarius vulgaris "Cuvier and Valenciennes" *in* Osorio, Jorn. Sci. Math. Phys. Nat. Lisboa, ser. 2, vol. 5, No. 19, p. 198, 1898 (name only; nomen nudum; St. Thomas Island).

Chironectes barbatulus Eydoux and Souleyet, Voyage autour du Monde . . . *La Bonite*, Zool., vol. 1, pt. 2, Poissons, p. 184, pl. 5, fig. 1, 1842 (locality not known but undoubtedly the Pacific).

Photographs of specimens and drawings used in this paper were made by the Smithsonian Institution Photographic Laboratory.

Explanation of abbreviations used in figure 1

ads – All dorsal spines long and slender.
ba – Bait absent.
bb – Bait bifid.
bf – Bait filamentous and bulbous.
bs – Bait simple.
bt – Bait trifid.
cpa – Caudal peduncle absent.
cpa-d – Caudal peduncle absent or distinct.
cpd – Caudal peduncle distinct.
dse – All spines embedded.
dsf – Dorsal spines free, movable.
d11–14 or d15–16 – Number of soft dorsal rays.
fds – First dorsal spine long and slender.
gf ¼ – Gill filaments on ¼ of first gill arch.
gf ¾ – Gill filaments on ¾ of first gill arch.
gn – Gill opening normal in position.
gp – Gill opening posterior in position.
pel – Pelagic habitat.
p7 or p8–14 – Number of pectoral fin rays.
sc – Bony scutes present.
sed – Sedentary habitat.
sfd – All soft dorsal rays divided.
sfds – All soft dorsal rays simple.
sf0–2d – Any of last two soft dorsal rays may or may not be divided.
sfpd – Soft rays of pectoral all divided.
sfps – Soft rays of pectoral all simple.
sfvd – Soft rays of pelvic all divided.
sfvs – Soft rays of pelvic all simple.
skc – Skin profusely covered with cirri.
skd – Skin denticulate.
skn – Skin naked.
skvd – Skin with long upstanding denticles or cirri.

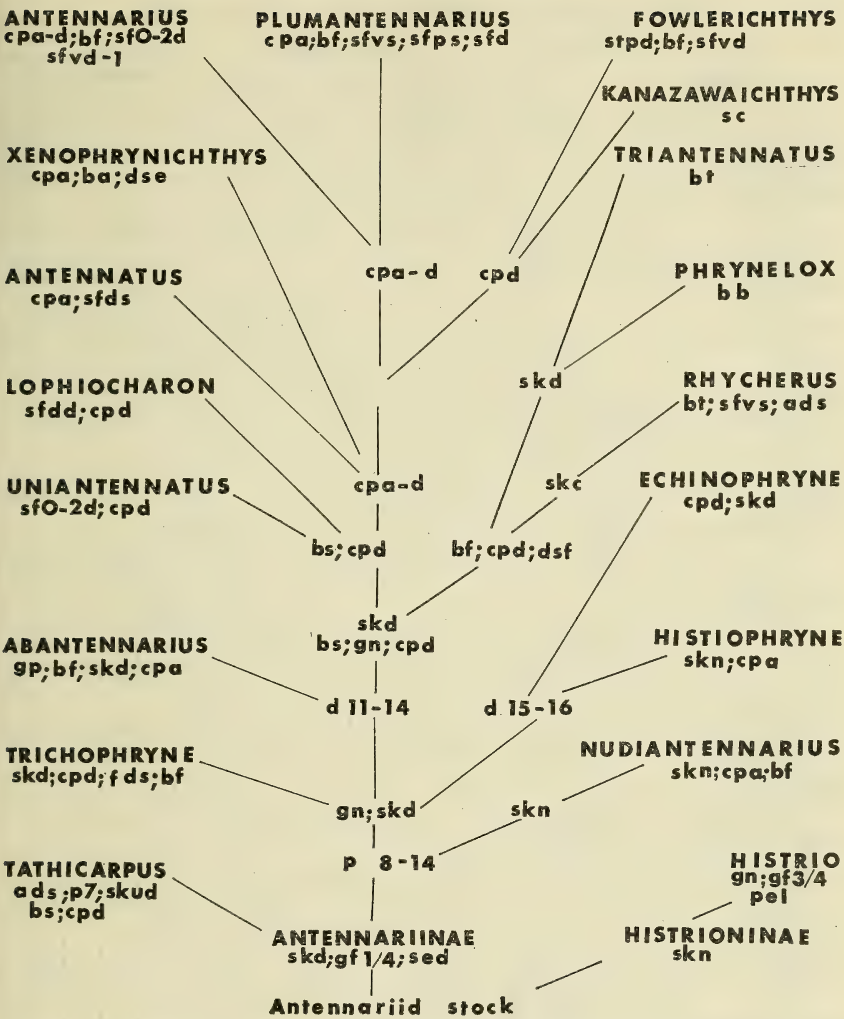

Figure 1.—Presumed phylogeny of the Antennariidae. Explanation of abbreviations on facing page.

Artificial key to the genera, subgenera, and species of the Antennariidae

1a. Dorsal part of first gill arch without filaments, ventral part with only anterior half bearing filaments; no dermal cirrus at tip of chin nor on snout in front base of first dorsal spine; a small flaplike cirrus at symphysis of premaxillaries between dentigerous parts . . . (Subfamily Antennariinae.) (p. 62)

2a. Occipital region of head with a thickened and raised bilaterally symmetrical bony armor that extends anteriorly along dorsal edge of orbits; these two scutes are fused along the middorsal line except around the third dorsal spine and its membrane; a similar bony plate below each eye; none of dorsal spines embedded; tip of first dorsal spine consists of a nonfilamen-

TABLE 1.—*Counts recorded for species of* Antennariidae

Genera, subgenera, and species	Number of fin rays																		
	Soft dorsal						Anal					Pectoral							
	11	12	13	14	15	16	6	7	8	9	10	7	8	9	10	11	12	13	14
Kanazawaichthys																			
scutatus			4						3	1								8	
Tathicarpus																			
*butleri**	3							3				3							
butleri	1							1				2							
Trichophryne																			
rosaceus		2						1	1						4				
*mitchelli**			1	2					2	1					1	2			
Nudiantennarius																			
subteres		1						1						2					
Abantennarius																			
duescus		2						2						4					
analis		1						1							2				
Rhycherus																			
*filamentosus**			3						3							3			
Histiophryne																			
*bougainvilli**					3				3				3						
*scortea**					3				3						1	2			
Echinophryne																			
*crassispina**					1	1			2	1	1				1	2			
*glauerti**						1			1							1			
Phrynelox																			
Phrynelox																			
*striatus**		1	1				1	1							2				
*melas**		2					1	1							2				
nuttingi		10						10							2	14			
scaber	1	38	1					39	1						3	59			
Triantennatus																			
cunninghami		1						1						1	1				
zebrinus		6					1	5							10	1			
atra		3						3							6				
nox		3						3							1	5			
tridens		30	1					32								53	2		
Antennatus																			
Antennatus																			
bigibbus		4	3					6	1						2	12			
strigatus		6						6						1	9				
Xenophrynichthys																			
cryptacanthus		1	1					2					2						
Lophiocharon																			
Lophiocharon																			
caudimaculatus		1	5					6						8	2				
Uniantennatus																			
*campylacanthus**	1							1							1				
horridus		1							1							2			
*horridus**		2	2						3	1					1	2	1		
*tenebrosus**		1						1							1				
tenebrosus		1						1							2				
Antennarius																			
Fowlerichthys																			
radiosus		1	75	6					79									99	5
avalonis		1	22						23									44	
*sarasa**			1						1									1	
ocellatus			17						17							3	26	3	
Plumantennatus																			
asper			2					2						4					
Antennarius																			
*oligospilos**		1						1							1				
hispidus		1	3					4							8				
*moluccensis**			2						2							2			
moluccensis			5						5							9			
*leucosoma**		1					1								1				
pardalis	?1								?1						?1				
chironectes	1	7					1	6							13				
multiocellatus	1	5					1	5							11				
*phymatodes**	1	1						2							2				
phymatodes		1						1							2				
sanguineus			7					5	2							11	3		
drombus		15	1					15								7	18	1	
coccineus		21					1	19						2	38	1			
bermudensis		2						2						2	2				
*dorehensis**		1						1						1					
*notophthalmus**		3						3						3	1				
notophthalmus		2						2						3	1				
verrucosus		2						2								4			
altipinnis		18	1					16	3					33	5				
pauciradiatus		13						12	1				2	21	1				
nummifer		22						22							34	4			
Histrio																			
histrio	3	32	2					30	2					2	72	4			

*From literature.

tous bulbous "bait." (Gulf of Mexico; probably pelagic.) (***Kanazawaichthys,*** new genus.) . . . . **scutatus,** new species (p. 63)

2b. Head without bony armor as above.

3a. First, second, and third dorsal spines embedded, covered over with granular skin; bait not externally visible; soft dorsal and anal fins membranously attached to base of caudal fin; all fin rays simple except those of caudal fin; soft dorsal rays 12 or 13; anal 7; pectoral 8. (East Indies, Karakelang and Rotti Islands) (Genus ***Antennatus, Xenophrynichthys,*** new subgenus.) (p. 81).
cryptacanthus (Weber) (p. 82)

3b. First dorsal spine not embedded, but freely movable, usually bearing bait at its distal tip.

4a. Second dorsal spine slender, elongate, its length contained fewer than 2.8 times in length of base of soft dorsal fin.

5a. Pectoral rays 7; first dorsal spine long, slender, hairlike, smooth, bearing at its tip a simple bannerlike tentacle; third dorsal spine very elongate and slender, much longer than second; unusually elongate upstanding denticles on skin even on fins; all soft dorsal, pelvic, and pectoral rays simple; anal rays all divided; caudal peduncle distinct; all fin rays notably elongate; dorsal soft rays 11; anal 7. (Genus ***Tathicarpus.***) (p. 64)
butleri Ogilby (p. 64)

5b. Pectoral rays 9 to 11; first dorsal spine not as above, third dorsal spine robust, shorter than or same length as second.

6a. (See 6b and 6c.) Skin prickly or covered with granules; caudal peduncle distinct; first dorsal spine very slender, almost hairlike, about as long as or longer than second dorsal spine; first spine bristly and with filamentous tip. (Genus ***Trichophyrne.***) (p. 65)

7a. Soft dorsal rays 12; ocellate dark spot basally at second third of length of soft dorsal fin. (Philippines.)
rosaceus (Smith and Radcliffe) (p. 65)

7b. Soft dorsal rays 13 or 14, skin covered with upstanding spiniform bristles. (Australia.) . . . . . **mitchelli** (Morton) (p. 65)

6b. Skin smooth, at most with only scattered microscopic size denticles; caudal peduncle absent or nearly so; first dorsal spine short with bulbous tip; dorsal soft rays 12; anal 7, pectoral 9. (Philippines.) (***Nudiantennarius,*** new genus.) (p. 66)
subteres (Smith and Radcliffe) (p. 66)

6c. Skin without denticles but these are replaced by a profusion of fleshy tentacles or cutaneous appendages everywhere; bait trifid, two large tentacles with a stubby one basally between them; last pelvic ray simple; soft dorsal rays 13; anal 8; pectoral 11. (Southern Australia.) Genus ***Rhycherus.***)
filamentosus (Castelnau) (p. 68)

4b. Second dorsal spine robust like the third, short, its length contained 3 or more times in the length of base of soft dorsal fin.

8a. Gill opening behind pectoral fin "elbo" by a distance equal to or greater than least depth of the indistinct caudal peduncle; soft dorsal rays 12; anal 7. (***Abantennarius,*** new genus.) (p. 66)

9a. Gill opening about halfway between pectoral fin base and anal fin origin, pectoral rays 9. (Hawaiian Islands.)
duescus (Snyder) (p. 66)

9b. Gill opening adjacent to anal fin origin; pectoral rays 10. (Hawaiian Islands.) . . . **analis** Gosline, new species (p. 67)

8b. Gill opening adjacent to pectoral fin "elbo."

10a. Soft dorsal rays 15 or 16.

11a. Skin smooth, at most with only microscopic size spicules; caudal peduncle absent; none of soft rays of dorsal or anal fins divided. (Genus ***Histiophryne.***) (p. 69)

12a. Pectoral rays 8; second and third dorsal spines not movable, covered with thick skin. (Southern Australia.)
bougainvilli (Cuvier and Valenciennes) (p. 69)

12b. Pectoral rays 10 or 11; second and third dorsal spines movable. (Southern Australia.)
scortea McCulloch and Waite (p. 69)

11b. Skin everywhere covered with bristles; caudal peduncle distinct or nearly so; anal rays 8 to 10; pectoral 10 or 11. (Genus ***Echinophryne.***) (p. 70)

13a. First dorsal spine stout, covered with prickles; body covered with upstanding bristles; none of soft dorsal or anal rays divided. (Southern Australia.)
crassispina McCulloch and Waite (p. 70)

13b. First dorsal spine slender, smooth, with simple tentacle, last few soft dorsal rays and anal rays divided. (Western Australia.) . . . . **glauerti** Whitley (p. 70)

10b. Soft dorsal rays 11 to 14.

14a. Fleshy tip of first dorsal spine consists of distinct bifid or trifid tentacles, often with filaments, but usually without basal filaments, anal rays 6 or 7; last 2 or 3 rays of soft dorsal divided; all anal rays divided; all pectoral rays simple; caudal peduncle distinct. (Genus ***Phrynelox.***) (p. 71)

15a. Bifid tentacles at tip of first dorsal spine; dorsal soft rays usually 11 or 12, rarely 13; pectoral 10 or 11. (Subgenus ***Phrynelox.***) (p. 71)

16a. Bony part of first dorsal spine almost twice length of second dorsal spine.

17a. Body striped with brown markings more or less resembling a zebra. (Tropical Western Pacific and Indian Ocean.) . . . . **striatus** (Shaw) (p. 71)

17b. Body with ocellate spots and somewhat mottled or plain blackish. (Tropical Western Pacific and Indian Ocean.) . . . . . . **melas** (Bleeker) (p. 72)

16b. Bony part of first dorsal spine only slightly longer or about same length as second dorsal spine.

18a. Color plain black or dark brown. (Western Atlantic.)
nuttingi (Garman) (p. 72)

18b. Body striped with dark brown markings resembling a zebra; fins with dark brown spots. (Western Atlantic.) . . . . **scaber** (Cuvier) (p. 73)

15b. Trifid tentacles at tip of first dorsal spine (rarely is one of these tentacles missing from injury); dorsal soft rays usually 12. (***Triantennatus,*** new subgenus.) (p. 74)

19a. Pectoral rays 10, occasionally 9 or 11.

20a. Body striped with dark brown markings on a pale background, more or less zebralike.

21a. About 4 to 6 dark stripes on soft dorsal fin, and other widely spaced ones on body; pectoral rays 9 or 10. (Hawaii.) . . . . **cunninghami** (Fowler) (p. 74)

21b. Dark stripes on fins and body very numerous and closely packed; pectoral rays 10, occasionally 11. (Australia.) . . . . **zebrinus,** new species (p. 75)

20b. Color black; fin rays notably black, not white-tipped, except pectorals are slightly pale. (Sydney, Australia.) . . . . **atra,** new species (p. 76)

19b. Pectoral rays 11, occasionally 10.

22a. Color black, or dark brown; pectoral rays white-tipped. (Japan.) . . . . **nox** (Jordan) (p. 78)

22b. Color mottled or striped with dark brown; fins and belly dark-spotted. (Japan; Mauritius.)
tridens (Temminck and Schlegel) (p. 79)

14b. Fleshy tip of first dorsal spine consists of a simple tentacle or is filamentous or bulbous with or without filaments or a combination of any of these.

23a. Bony part of first dorsal spine notably slender, its fleshy tip consisting of a nonfilamentous simple slender tentacle, sometimes somewhat lanceolate.

24a. Caudal peduncle absent, or indistinct.

25a. All rays of soft dorsal simple; skin thick and firm, covered with shagreenlike denticles; third dorsal spine bound down with skin; no naked area behind second or third dorsal spines; body mottled with brown or a very coarse network of brown; usually a dark bar across anal fin and basally across caudal fin. (***Antennatus,*** new genus and new subgenus.) (p. 80)

26a. Pectoral rays 11, occasionally 10; first dorsal spine notably longer than second dorsal spine. (Central and Western Pacific and Indian Ocean.)
bigibbus (Lacepède) (p. 80)

26b. Pectoral rays usually 10, occasionally 9; first dorsal spine about same length as second dorsal spine. (Eastern Pacific.) . . . **strigatus** (Gill) (p. 81)

25b. Dorsal soft rays all divided; no pelvic ray divided; body rather profusely covered with dark specks and irregularly shaped dark and light marks; pectoral rays usually 9, occasionally 10; anal 7. (Eastern and Western Pacific and Indian Ocean.) (Genus and subgenus ***Lophiocharon.***)
caudimaculatus (Rüppell) (p. 82)

24b. Caudal peduncle distinct; third dorsal spine movable; last 2 or 3 or none of the soft dorsal rays divided; pectoral rays 10 to 12. (***Uniantennatus,*** new subgenus.) (p. 83)

27a. Bony part of first dorsal spine shorter than second dorsal spine; dorsal soft rays 11; pectoral 10; anal 7; median fins with several large ocellate spots; 3 large ocellate spots on each side of the body; last 3 soft dorsal rays divided. (Guinea, West Africa.)
campylacanthus (Bleeker) (p. 85)

27b. Bony part of first dorsal spine as long as or longer than second dorsal spine; dorsal soft rays 12 or 13; pectoral rays 10 to 12; only last 2 or 3 soft dorsal rays divided.

28a. Anal rays 8 or 9; color dark brown, spotted with blackish; some ocellate spots present. (Tropical Central and Western Pacific.)
horridus (Bleeker) (p. 84)

28b. Anal rays 7; color brownish, marbled with bright yellow when alive; pectoral, dorsal, anal, and caudal fins with several distinct ocellate spots (Western Atlantic.) . . . . **tenebrosus** (Poey) (p. 83)

23b. Fleshy tip of first dorsal spine consists of a group of filaments or a ribbonlike tentacle with filaments or tentacles or a bulbous tip or combination of these. (Genus ***Antennarius.***) (p. 85.)

29a. All or at least last 8 of the soft dorsal rays divided.

30a. All of the pelvic soft rays divided; caudal peduncle distinct, bait consists of a tuft of tentacles or a bulbous-like bait; soft dorsal rays usually 13; anal 8. (Subgenus ***Fowlerichthys.***) (p. 86.)

31a. Bony part of first dorsal spine longer than second dorsal spine; pectoral rays 13 or 14, undivided; soft dorsal fin rays all divided; an ocellate spot basally a little behind middle of length of soft dorsal fin; bulbous tip of bait usually very small. (Western Atlantic.) . . . **radiosus** Garman (p. 87)

31b. Bony part of first dorsal spine shorter than or about as long as second dorsal spine; all pectoral rays divided except possibly in *sarasa*.

32a. Pectoral rays 13.

33a. Soft dorsal rays all divided except possibly first 2 or 3 in small specimens; an ocellate spot posterobasally on soft dorsal fin; scattered brown spots on fins and body. (Catalina Island; México; Panamá; Perú.)
avalonis Jordan and Starks (p. 87)

33b. First 5 soft dorsal rays may be undivided, at least the last 8 are divided; no ocellate spot on soft dorsal; coloration consists of dark brown background overlaid with reticulations and dark streaks. (Japan.) . **sarasa** Tanaka (p. 88)

32b. Pectoral rays usually 12, occasionally 11 or 13; a large ocellate spot basally on middle of soft dorsal fin and one below it on midside of body; usually tiny dark brown spots scattered on body; caudal fin with or without a large ocellate spot; all of soft dorsal, pelvic, and pectoral rays branched. (Western Atlantic.)
ocellatus (Bloch and Schneider) (p. 89)

30b. Pelvic rays all simple or undivided; caudal peduncle absent; pectoral rays 9; dorsal soft rays 13; body profusely marked with small brown spots or blotches

on a pale background, some of these dark blotches have pale centers on caudal fin or color is plain black with tips of rays white; median fins distally broadly margined with white. (Australia, Singapore.) (***Plumantennatus***, new subgenus.) (p. 89)

asper Macleay (p. 89)

29b. None or only last 2 or 3 rays of soft dorsal are divided; none or only last pelvic ray divided; pectoral rays all simple. (Subgenus ***Antennarius***.) (p. 90)

34a. Some "warts" on skin; none of the anal, dorsal or pelvic rays are branched or divided; dorsal rays 11 or 12; anal 7; pectoral 10. (Western Pacific.)

phymatodes Bleeker (p. 90)

34b. No "warts" on skin; all anal rays divided except possibly the first.

35a. None of the soft dorsal rays are branched or divided; last pelvic ray probably divided; bony part of first dorsal spine slightly longer than second dorsal spine and bearing a tuft of tentacles at its distal tip; dorsal rays 11 or 12; anal 7; pectoral 9 or 10.

36a. Dorsal rays usually 11; caudal peduncle distinct; body and fins with several black ocellate spots; body, including abdomen, with numerous small blackish spots; background color reddish brown. (West coast of Africa.)

pardalis (Cuvier and Valenciennes) (p. 92)

36b. Dorsal rays 12; caudal peduncle almost absent; a single large ocellate spot at beginning of last third of length of soft dorsal base, this spot more on body than on dorsal fin; body and fins speckled with tiny dark spots. (Bermuda.)

bermudensis, new species (p. 98)

35b. Last 2 or 3 soft dorsal rays divided, except none may be divided in *multiocellatus*.

37a. Bony part of first dorsal spine longer than second dorsal spine.

38a. Body without "warts" on skin.

39a. Body striped with black or brown marks, more or less zebralike; bony part of first dorsal spine about same length as second dorsal spine, the fleshy tip consists of an elongate filamentous tentacle; an ocellus may occur basally in soft dorsal fin; dorsal rays 13; anal 7; pectoral 10. (Philippines, East Indies, Japan.)

hispidus (Bloch and Schneider) (p. 90)

39b. Body not striped like a zebra.

40a. Dorsal soft rays 13; anal 8; pectoral 11; large adults have a profusely black spotted and reticulated color pattern, or it may be mottled light and dark with scattered tiny black specks; small specimens have a few ocellate spots on fins and

body; no smooth pit behind second dorsal spine. (Tropical Pacific.)
moluccensis Bleeker (p. 91)

40b. Dorsal soft rays 11 or 12; anal 6 or 7; pectoral 10.

41a. Color white or nearly so, finely peppered with dark dots on body and fins. (Western Pacific.)
leucosoma Bleeker (p. 92)

41b. Color not as above; two color phases occur or a combination of these may occur; one is black with tips of rays of paired fins white; the other color phase is usually mottled light brownish and marked with ocellate spots; occasionally ocellate spots are visible in the black color phase; bait usually consists of a ribbonlike tentacle with filaments, or a tuft of filaments.

42a. Abdomen with scattered but numerous small blackish ocellate spots in pale color phase; naked area behind the second dorsal spine becomes denticulate on the large adults of this species; no dark spot each side of third dorsal spine. (Indo-Pacific.)
chironectes Lacepède (p. 93)

42b. Abdomen unspotted in pale color phase, a black spot basally each side of third dorsal spine; in black color phase a whitish spot on dorsal edge of caudal peduncle just behind rear of base of soft dorsal. (Western Atlantic.)
multiocellatus (Cuvier and Valenciennes) (p. 94)

38b. Body with some warts; last 3 soft dorsal rays divided; caudal peduncle distinct, longer than deep; dorsal 12; anal 7; pectoral 10; no pelvic ray branched. (Western Pacific and Indian Ocean.)
oligospilos Bleeker (p. 95)

37b. Bony part of first dorsal spine about as long as or shorter than second dorsal spine.

43a. Body striped with dark brown, more or less zebralike; dorsal rays 12 or 13; anal 7; pectoral 10, rarely 11 (Western Pacific and Indian Ocean.) . **hispidus** (Bloch and Schneider) (p.90)

43b. Body not striped like a zebra; anal rays 7 or 8.

44a. Soft dorsal rays 13; pectoral 11 or 12; anal 7 or 8; belly with scattered blackish or dark brown spots (absent in young) notably much larger than dark spots elsewhere if latter were present; fleshy tip of first dorsal

spine with some blackish tentacles; only last 2 or 3 soft dorsal and last pelvic rays branched; caudal peduncle scarcely present. (Eastern Pacific.) . . . . **sanguineus** Gill (p. 95)

44b. Soft dorsal rays normally 11 or 12, rarely 13; anal rays normally 7, occasionally 8.

45a. Caudal peduncle absent or scarcely present, dorsal and anal fins join at or very close to base of caudal fin rays; dorsal rays 12; last two or three rays of soft dorsal divided; last pelvic ray divided.

46a. No ocellate spot in soft dorsal.

47a. Pectoral rays 11 or 12; median fins finely brown spotted; background color brownish to light brownish, mottled or finely spotted. (Hawaii; Cocos Island.)
drombus Jordan and Evermann (p. 96)

47b. Pectoral rays 10, occasionally 9 or 11; body sometimes profusely peppered with dark dots. (Central and West Pacific and Indian Oceans.)
coccineus (Lesson) (p. 97)

46b. A single large occellate spot at beginning of last third of length of soft dorsal, this spot more on body than on dorsal fin; body and fins speckled with tiny dark spots; pectoral 9 or 10. (Bermuda.)
bermudensis, new species (p. 98)

45b. Caudal peduncle present, distinct.

48a. Color black; body with minute white specks; no ocellate spot; dorsal 12; anal 7; pectoral 9; last pelvic ray undivided. (Western Pacific.)
dorehensis Bleeker (p. 97)

48b. Color not as above.

49a. Last pelvic ray simple or undivided; pectoral rays 9, rarely 10; ocellate spot on soft dorsal fin, blackish bar on body below area between third dorsal spine and origin of soft dorsal. (Western Pacific.)
notophthalmus Bleeker (p. 99)

49b. Last or fifth pelvic ray divided.

50a. Pectoral rays 11; color pattern consisting of brown streaks and blotches, some of which have pale centers. (Western Atlantic.)
verrucosus Bean (p. 99)

50b. Pectoral rays normally 9 or 10.

51a. Pectoral rays usually 9, occasionally 10.

52a. General coloration dark brown and somewhat dark spotted but cirri on body are usually white; median fins notably dark brown except distally with broad white or pale edges; a pale bar across caudal fin basally. (Western Pacific.)
altipinnis Smith and Radcliffe (p. 99)

52b. General coloration light brown with a very small ocellate spot at about beginning of last third of length of soft dorsal base, this spot more on dorsal fin than on body. (Florida and Cuba.)
pauciradiatus, new species (p. 100)

51b. Pectoral rays normally 10, occasionally 11; usually an ocellate spot basally on soft dorsal fin at about beginning of last third of its length; background color light tan to dark brown, usually somewhat mottled; a smooth pit or area behind second dorsal spine. (Central and Western Pacific; Indian Ocean.)
nummifer (Cuvier) (p. 102)

1b. Dorsal part of first gill arch with the posterior half only bearing filaments; ventral part of first gill arch with gill filaments along its entire length; two dermal cirri on middorsal line of snout in front of base of first dorsal spine; dermal flap at symphysis of premaxillaries absent or represented by a low fold of skin. (Subfamily Histrioninae; genus ***Histrio*** pelagic in Atlantic, Pacific, and Indian Oceans.) . . . . **histrio** (Linnaeus) (p. 103)

Family ANTENNARIIDAE

Subfamily Antennariinae

Kanazawaichthys, new genus

Genotype: *Kanazawaichthys scutatus*, new species.

This new genus of antennariid differs from all other genera in the family by having two pairs of bony plates on the head. The largest pair covers all of the dorsoposterior part of the head behind and above orbits. A small plate is below each eye. Otherwise this genus has the characters of *Antennarius*.

The genus is named in honor of Robert H. Kanazawa, museum aide in the Division of Fishes, U. S. National Museum (USNM),

who observed three unique specimens while sorting specimens from the *Oregon* collections and kindly brought them to my attention.

Kanazawaichthys scutatus, new species

Plate 14,a

Holotype: USNM 157919, from Gulf of Mexico, *Oregon* Station 1273, long. 87°51′ W., lat. 28°10′ N., Mar. 9, 1955. Probably picked up in a dipnet near surface. Standard length 28.5 mm.

Paratypes: USNM 157920, collected with holotype and bearing same date, two specimens, 15.8 and 29.5 mm.; USNM 174946, Gulf of Mexico, Oregon Station 1370, long. 88°00′ W., lat. 28°55′ N., Aug. 20, 1955, taken from stomach of yellowfin tuna, standard length 17 mm.

Description: Certain counts are recorded in table 1 (p. 54).

The bony part of the first dorsal spine, slightly shorter than the second, bears at its tip the fleshy bait which consists of a nonfilamentous bulb; the second and third spines are movable but membranously connected to the head; all soft rays of anal, caudal, and pelvic are branched; last 10 to 12 soft dorsal rays branched; pectoral rays all simple; gill opening close to pectoral fin base; caudal peduncle distinct, deeper than long; skin with tiny denticles somewhat embedded; dermal cirri scattered on body and head.

Detailed measurements were made on the holotype and two paratypes and these data, expressed in thousandths of the standard length, are recorded respectively. Standard length 28.5, 29.5 and 15.8 millimeters. Greatest depth of body 592, 572 and 634; length of bony part of first dorsal spine 202, 190 and 165; of second 158, 167 and 146, of third 173, 190 and 158; longest soft dorsal ray 271, 248 and 215; longest middle caudal ray 394, 404 and 462; length of head from snout tip to middle of gill opening 611, 596, and 620; length of maxillaries 252, 228 and 203; least depth of caudal peduncle 128, 114 and 127; length of caudal peduncle 94, 86 and 64; length of base of soft dorsal fin 518, 500 and 506; diameter of eye 128, 133 and 127; bony width of interorbital space 99, 95 and 108.

Color in alcohol: Fins, head, and body light straw colored; body with scattered dark pigment spots; fins probably pink when alive as there are traces of that color still evident.

Remarks: This remarkable new species of frogfish is unlike any other antennariid known to me by having the remarkable bony scutes or armor on the head. I suspect this species is pelagic and that these thickened bony plates act as a floating mechanism. Consideration was given to the possibility that this species might represent the young stage of some known species of frogfish and that at a later stage these plates might be lost.

The four species referred to the subgenus *Fowlerichthys* are closest to *Kanazawaichthys scutatus* in regard to most characters except the lack of bony plates. Anal, dorsal, and pelvic soft rays all divided, and also identical in number. *A. avalonis* and *A. sarasa* are from the Pacific, but *A. radiosus* and *A. ocellatus* are from the Western Atlantic. Our large series of *A. radiosus* includes the sizes of the types of *K. scutatus*, and no bony armor is present on the head even though pectoral rays are of same number.

A. ocellatus, with the usual number of 12 pectoral rays occasionally 11 or 13, differs from *K. scutatus*, which has 13. Furthermore, specimens of *A. ocellatus* from the Gulf of Mexico measuring 22 and 26 mm. show no sign of any bony plate. Other specimens of *A. ocellatus* ranging in size from 15.5 mm. and longer show no trace of the plates which characterize *K. scutatus*.

We conclude, therefore, that this new genus and species represents a phyletic line differing from all other genera in the family.

The species is named *scutatus* in reference to the bony scutes on the head.

Genus *Tathicarpus* Ogilby

Tathicarpus Ogilby, Proc. Roy. Soc. Queensland, vol. 20, p. 19, Jan. 2, 1907 (genotype, *Tathicarpus butleri* Ogilby).

This genus is characterized by having a simple tentacle at tip of first dorsal spine in combination with a distinct caudal peduncle, none of the soft dorsal or pelvic rays branched, and seven pectoral fin rays.

Tathicarpus butleri Ogilby

PLATE 1,A

Tathicarpus butleri Ogilby, Proc. Roy. Soc. Queensland, vol. 20, p. 20, Jan. 2, 1907 (type locality, Port Curtis, east coast of Queensland).

Tathicarpus mucosum Ogilby, Proc. Roy. Soc. Queensland, vol. 20, p. 22, 1907 (type locality, Port Curtis, Queensland).

Tathicarpus appeli Ogilby, Mem. Queensland Mus., vol. 7, pt. 4, p. 303, pl. 19, fig. 2, 1922 (type locality, Wide Bay, South Queensland).

This is the only known species of antennariid with only seven pectoral rays. *A. butleri* is characterized by the unusually elongate denticles of the skin, which even occur as spinules on the fins; all fin rays are unusually elongate for an antennariid, especially the second and third dorsal spines, which are elongate and slender; the first dorsal spine is long and threadlike, bearing at its tip a simple slender tentacle; these somewhat extreme characters no doubt were the reason Ogilby established the genus *Tathicarpus* for this species.

The only specimen that I have studied (USNM 164195 from Jarape, north coast of Groote Eylandt, North Australia, collected by Robert R. Miller) has the soft dorsal fin damaged, but all rays appear to be simple; none of the pelvic or pectoral rays are divided; anal rays all divided; no naked area behind second dorsal spine; the length of the latter contained 2¾ times in base of soft dorsal; caudal peduncle distinct.

Genus *Trichophryne* McCulloch and Waite

Trichophryne McCulloch and Waite, Rec. Australian Mus., vol. 1, No. 1, p. 68, 1918 (genotype *Antennarius mitchelli* Morton).

This genus is characterized by the long slender second dorsal spine, the length of which is contained 2.8 or fewer times in the length of the base of the soft dorsal fin. In most species of antennariids the second dorsal spine is embedded or short and robust and contained more than 3½ times in length of base of soft dorsal fin.

Trichophryne rosaceus (Smith and Radcliffe)

Plate 1,b

Antennarius rosaceus Smith and Radcliffe, *in* Radcliffe, Proc. U. S. Nat. Mus., vol. 42, p. 203, pl. 17, fig. 2, 1912 (type locality, Romblon, Philippine Islands; holotype, USNM 70266).

This distinctive species may be recognized by the long slender rough second dorsal spine and the still longer threadlike first dorsal spine with a bulbous tuft of filaments at its tip. It differs from its closest relative, *A. mitchelli*, in having 12 dorsal soft rays instead of 13 or 14, last 2 or 3 soft dorsal rays divided, last pelvic ray divided, and all anal rays divided.

Two specimens of this species are known—the holotype, and another specimen measuring 13.5 mm. in standard length from Bikini Atoll, USNM 113991.

Trichophryne mitchelli (Morton)

Plate 1,c

Antennarius mitchelli Morton, Papers Proc. Roy. Soc. Tasmania 1896, p. 98, July 1897 (type locality, East Coast, Tasmania).

Trichophryne mitchelli McCulloch and Waite, Rec. Australian Mus., vol. 1, No. 1, p. 68, pl. 6, fig. 1, 1918 (Brighton Beach, South Australia; off Wilson's Promontory, Victoria).—Waite, The fishes of South Australia, p. 211, fig. 303, 1923 (South Australia).

I have not seen a specimen of this species. It is known from the records listed in the synonymy.

The figure by McCulloch and Waite shows none of the dorsal, anal, pectoral, or pelvic rays divided; caudal peduncle distinct; first dorsal ray long, slender, spinate, with dermal tentacles at its tip.

Nudiantennarius, new genus

GENOTYPE: *Antennarius subteres* Smith and Radcliffe.

This new genus is characterized by having naked skin or almost naked skin with only microscopic sized embedded denticles scattered on head and body in combination with a long slender second dorsal spine; short first dorsal spine with bait consisting of a tuft of tentacles.

The genus is named in reference to an antennariid with naked skin.

Nudiantennarius subteres (Smith and Radcliffe)

PLATE 1,D

Antennarius subteres Smith and Radcliffe, *in* Radcliffe, Proc. U. S. Nat. Mus., vol. 42, p. 205, pl. 17, fig. 1, 1912 (type locality, Lingayen Gulf, Philippines; holotype, USNM 70268).

This species is characterized by having an almost naked skin, with only microscopic size denticles scattered in the skin; first dorsal spine short, the bait consisting of a tuft of tentacles; last three soft dorsal rays divided; anal rays divided; pelvic and pectoral rays all simple; second dorsal spine long and slender, covered with numerous denticles, its length a little over twice in base of soft dorsal; third dorsal spine with free tip, but mostly bound down with skin, denticles only present on free portion; caudal peduncle present; background color brown, mottled with darker brown; tips of rays of median fins white; pectoral rays with distal half free or excerted beyond membranes (drawing of holotype is in error in regard to that character).

This species is known only from the holotype, which I have studied.

Abantennarius, new genus

GENOTYPE: *Antennarius duescus* Snyder.

This new genus is characterized by having the gill opening remote from the "elbo" of the pectoral fin. The gill opening is considerably behind the usual position. Other characters are indistinct caudal peduncle, no pelvic or pectoral ray divided, last two soft dorsal rays divided, and all anal rays divided. The bait consists of a tuft of filaments.

The genus is named in reference to an antennariid with the gill opening remote from or away from its usual position near the base of pectoral fin.

Abantennarius duescus (Snyder)

PLATE 2,A

Antennarius duescus Snyder, Bull. U. S. Fish Comm., vol. 22, p. 537, pl. 13, fig. 24, 1904 (type locality, *Albatross* Station 3872, Auan Channel, 32 to 43 fathoms, between Maui and Lanai; holotype, USNM 50884; paratype, USNM 126597,

Albatross Station 4128, near Kauai in 75 fathoms); *ibid.*, vol. 23, p. 522, pl. 65, fig. 2, 1905 (channel between Maui and Lanai; Kauai).

This species has the gill opening on the side of the body remote from the "elbo" of the pectoral fin; the first dorsal spine is about same length as second dorsal spine and bears a tuft of filaments; no naked area behind second dorsal spine; caudal peduncle scarcely present; third dorsal spine movable.

I have studied the holotype and paratype.

Abantennarius analis Gosline, new species

Figure 2

Holotype: USNM 164419, Oahu, Waikiki reef, Dec. 31, 1952, Gosline and Randall, standard length 44 mm.

Description: The following counts were made on the only known specimen: Dorsal I–I–I,12; anal 7; pectoral 10 in both fins.

The following measurements are recorded in thousandths of the standard length: Greatest depth of body 586; length of bony part of first dorsal spine 202; of second dorsal spine 136; of third 159; longest soft dorsal ray 257; longest (middle) caudal ray 230; length of maxillaries 180; least depth of caudal peduncle 91; length of caudal peduncle or distance between vertical lines thru caudal fin base and rear bases of anal fin 34; length of base of soft dorsal fin 530; fleshy eye diameter 86; fleshy interorbital space 105; tip of snout to center of gill opening 898.

The bony part of the first dorsal spine is notably longer than the second, and bears at its tip the fleshy bait which consists of one large fleshy tentacle with a tuft of cirri on opposite side basally; skin behind base of second dorsal spine naked; second dorsal spine movable, but third is bound down with skin of body; soft dorsal rays all simple except last two, which are divided; none of pelvic or pectoral rays divided; anal rays divided; gill opening just above origin of anal fin; caudal peduncle very short, only a little distinct, much deeper than long; skin everywhere thickly covered with the usual bifid and trifid prickles; dermal cirri along lateral line and others on head.

Color in alcohol: Background color brown, overlaid with numerous small darker brown flakelike marks somewhat reticulated ventrally; there is a tiny black spot about an eye diameter behind eye and another on the midside a little in front and above pectoral fin base; a less distinct black spot occurs on the back near base of first soft dorsal ray; caudal, pelvic, and pectoral fins barred; edges of dorsal and anal fins pale.

Remarks: This new species differs from the only other member of the genus, *A. duescus*, in having 10 pectoral rays instead of 9; the gill opening is opposite the anal origin instead of halfway between pectoral

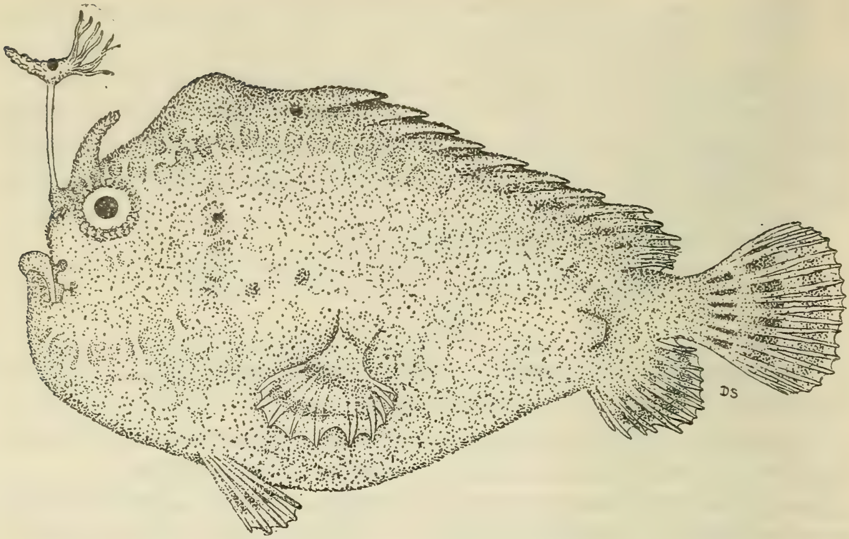

FIGURE 2.—*Abantennarius analis* Gosline, new species. Drawing by Mrs. D. B. Schultz of holotype, USNM 164419, from Waikiki, Oahu Island, Hawaii.

base and anal origin; first dorsal spine or "bait" is longer than second dorsal instead of same length; and there is a naked area behind base of second dorsal spine instead of prickly skin.

The species is named *analis* in reference to the location of the gill opening at origin of anal fin.

This species was recognized as new by Dr. Gosline, who kindly permitted me to include and describe it in this revision.

Genus *Rhycherus* Ogilby

Rhycherus Ogilby, Proc. Roy. Soc. Queensland, vol. 20, p. 17, 1907 (genotype, *Rhycherus wildi* Ogilby=*Chironectes filamentosus* Castelnau).

This genus is characterized by the absence of denticles in the skin, these are replaced by a profusion of fleshy tentacles or cutaneous appendages everywhere; the bait consists of two fleshy tentacles with a third small one between basally; all other antennariids with trifid tentacles forming the bait have the skin profusely denticulate and the last pelvic ray divided, but in this genus it is undivided.

Rhycherus filamentosus (Castelnau)

PLATE 2,B

Chironectes filamentosus Castelnau, Proc. Zool. Acclim. Soc. Victoria, vol. 1, p. 244, 1872 (type locality, St. Vincent Gulf, southern Australia).

Chironectes bifurcatus McCoy, Prodr. Zool. Victoria, vol. 2, dec. 13, p. 87, pl. 123, 1886 (type locality, Brighton Shore, Victoria).

Rhycherus wildi Ogilby, Proc. Roy Soc. Queensland, vol. 20, p. 18, 1907 (type locality, "Southern Australia" [Victoria]).

Rhycherus filamentosus McCulloch and Waite, Rec. Australian Mus., vol. 1, No. 1, p. 70, fig. 31, pl. 6, fig. 3, 1918 (Kangaroo Island; St. Vincent Gulf; Corny Point, and Palmerston, South Australia); Waite, The fishes of Southern Australia, p. 208, fig. 299, 1923 (South Australia).

This species is characterized by the profusion of fleshy tentacles, tubercles, or cutaneous appendages on head, body, and fins, along with the absence of the usual denticles in the skin; first dorsal spine long, slender, much longer than second dorsal spine, the bait consisting of two fleshy tentacles, with a small knob between them basally; second and third dorsal spines long, slender, and covered with tentacles; last soft rays of dorsal divided; anal rays probably all divided; pelvic and pectoral rays all simple; caudal peduncle distinct.

I have not seen a specimen of this species.

Genus *Histiophryne* Gill

Histiophryne Gill, Proc. U. S. Nat. Mus., vol. 1, p. 222, 1879 (genotype, *Chironectes bougainvilli* Cuvier and Valenciennes.)

This genus is characterized by having smooth skin or at most only microscopic size denticles; caudal peduncle absent, the dorsal and anal membranously attached to base of caudal fin; none of the dorsal, anal, pelvic, or pectoral rays divided; and with 15 or 16 soft rays in dorsal fin.

Histiophryne bougainvilli (Cuvier and Valenciennes)

Plate 2,c

Chironectes bougainvilli Cuvier and Valenciennes, Histoire naturelle des poissons, vol. 12, p. 431, 1837 (type locality not known).

Histiophryne bougainvilli, McCulloch and Waite, Rec. South Australian Mus., vol. 1. No. 1, p. 72, pl. 7, fig. 1, 1918 (St. Vincent Gulf, South Australia); Waite, The fishes of South Australia, p. 209, fig. 300, 1923 (South Australia).

This species has a tiny short naked first dorsal spine with a tiny bulbous "bait"; second and third dorsal spines bound down with skin; all rays of soft dorsal, anal, pelvic, and pectoral fins simple; soft dorsal and anal fins membranously attached to base of caudal fin rays; skin with microscopic sized denticles or almost smooth; the presence of 15 soft dorsal rays distinguishes this species from all antennariids except two other species, *scortea* and *crassispina,* which have smooth skin without prickles.

I have not seen a specimen of this species.

Histiophryne scortea McCulloch and Waite

Plate 2,d

Histiophryne scortea McCulloch and Waite, Rec. South Australian Mus. vol. 1, No. 1, p. 74, pl. 7, fig. 2, 1918 (type locality, Stansbury, St. Vincent Gulf,

South Australia); Waite, The fishes of South Australia, p. 209, fig. 301, 1923 (South Australia).

Histiophryne scortea inconstans McCulloch and Waite, Rec. South Australian Mus., vol. 1, No. 1, p. 75, 1918 (St. Vincent Gulf; Kingscote, Kangaroo Island, South Australia).

This species has a slender short first dorsal spine with a small bulbous tip; first and second dorsal spines with tips free, but enveloped in skin; all rays of soft dorsal, anal, pectoral, and pelvic fins simple; soft dorsal and anal fins membranously attached to caudal peduncle.

Color brownish with a white patch behind second dorsal spine, three other white marks dorsally on side of body.

I have not seen a specimen of this species.

Genus *Echinophryne* McCulloch and Waite

Echinophryne McCulloch and Waite, Rec. Australian Mus., vol. 1, No. 1, p. 66, 1918 (genotype, *Echinophryne crassispina* McCulloch and Waite).

This genus is characterized by having 15 or 16 soft dorsal rays along with the skin covered with denticles, and a distinct caudal peduncle.

Echinophryne crassispina McCulloch and Waite

Plate 3,a

Echinophryne crassispina McCulloch and Waite, Rec. South Australian Mus., vol. 1, No. 1, p. 67, pl. 6, fig. 2, 1918 (type locality, Spencer Gulf, South Australia); Waite, The fishes of South Australia, p. 210, fig. 302, 1923 (South Australia).

This species is one of only four known antennariids with 15 or 16 soft dorsal rays. It is distinguished from two, *bougainvilli* and *scortea,* by the distinct caudal peduncle and by the stubby first dorsal spine being covered with prickles and ending in a small fleshy process; second and third dorsal spines movable, the third somewhat bound down by skin to body. All fin rays simple except caudal fin rays, which are divided.

I have not seen a specimen of this species.

Echinophryne glauerti Whitley

Plate 3,b

Echinophryne glauerti Whitley, Australian Zool., vol. 10, pt. 3, 272, 1944 (type locality, Cottesloe Beach, Western Australia); Proc. Roy. Zool. Soc. New South Wales (1944), p. 28, fig. 5, 1944 (Cottesloe).

This species has not been well defined, but it may be recognized by its short simple first dorsal spine, last few rays of soft dorsal divided, along with 16 soft dorsal rays, and all 8 anal rays divided; pectoral 11, all rays simple; caudal peduncle not distinct; background color pale with widely scattered ocellate spots on head and body.

I have not seen a specimen of this species and refer it to this genus with some doubt.

Genus and subgenus *Phrynelox* Whitley

Phrynelox Whitley, Australian Zool., vol. 6, pt. 4, p. 328, 1931 (genotype, *Lophius striatus* Shaw 1794).

This genus is characterized by the bait consisting of bifid or trifid tentacles. The bifid tentacles forming the bait distinguishes the subgenus *Phrynelox* from the subgenus *Triantennatus*, which has three tentacles.

Phrynelox striatus (Shaw)

Plate 3,c

Lophius striatus Shaw, Naturalists miscellany, vol. 5, p. ?, pl. 175, 1794 (type locality, New Holland); Shaw, General zoology, vol. 5, pt. 2, p. 385, 1804 (Southern Seas).

Antennarius pinnaceps Bleeker (on Commerson), Acta. Soc. Sci. Indo-Neerlandicae, vol. 1, p. 49, 1856; Atlas ichthyologique . . ., vol. 5, p. 15, pl. 197, fig. 5, 1865 (Bali, Amboina); Cuvier and Valenciennes (Histoire naturelle des poissons, vol. 12, p. 410, 1837) use the names "*antennarius*" and "*pinnaceps*" of Commerson as common names). No valid scientific name as listed by Günther (Catalogue of the fishes in the British Museum, vol. 3, p. 190, 1861) occurs in Cuvier and Valenciennes (vol. 12, p. 410, 1837).

Antennarius lacepedei Bleeker, Acta. Soc. Sci. Indo-Neerlandicae, vol. 1, p. 50, 1856 (type locality, Amboina).

Antennarius pinnaceps var. *fasciata* Steindachner, Sitzb. Akad. Wiss. Wien, vol. 53, p. 457 (p. 34 in reprint), 1866 (type locality, Port Jackson, Australia).

Antennarius striatus Smith, The sea fishes of Southern Africa, p. 431, pl. 98, fig. 1240, 1949 (south to Port Alfred).

First dorsal spine much longer than second, bearing bifid tentacles at its tip; second and third dorsal spines movable; last 2 or 3 soft dorsal rays divided; anal rays all divided; pectoral and pelvic rays all simple; caudal peduncle distinct.

I have not examined a specimen of this species. It is distinguished by having bifid tentacles forming the bait along with 10 pectoral fin rays. In color pattern *striatus* resembles *tridens*, but the latter has trifid tentacles forming the bait and 11 pectoral fin rays. Doubt has been cast by authors that the character of the bait is reliable since it is possible that a fish might nip off one or more tentacles. I find no damage to the bait involving complete loss of these tentacles on specimens of related species studied. There are a few specimens in the National Museum collections in which the bait and spine are completely missing, but there is no way of knowing now whether this bait was broken off before preservation or afterward. The damaged base indicates loss of spine during collection or in preservation.

Phrynelox melas (Bleeker)

PLATE 4,A

Antennarius melas Bleeker, Acta Soc. Sci. Indo-Neerlandicae, vol. 2, p. 70, 1857 (type locality, Amboina); Atlas ichthyologique . . ., vol. 1, p. 20, pl. 199, fig. 6, 1865 (Amboina).

?*Antennarius güntheri* Bleeker, Ned. Tijdschr. Dierk., vol. 2, p. 275, 1865 (type locality, Amboina); Atlas ichthyologique . . ., vol. 1, p. 10, pl. 199, fig. 4, 1865 (Amboina).

Antennarius horridus (non Bleeker), Zatzow and Lenz, Abhandl. Senckenb. Naturf. Gesellsch., vol. 21, pt. 3, p. 511, pl. 35, fig. 7, 1898 (Zanzibar).

I have not seen a specimen of this species. It is the species in the Indo-Pacific with blackish coloration along with the bait consisting of bifid tentacles. *Antennarius nuttingi* in the Western Atlantic represents its closest relative.

First dorsal spine longer than second dorsal and bearing bifid tentacles at its tip; last 2 or 3 soft dorsal rays divided, last pelvic ray divided; pectoral rays all simple; anal rays all divided; caudal peduncle distinct.

Antennarius güntheri Bleeker, with bifid tentacles forming the bait, may belong here. The presence of "warts" on the skin may be a pathological condition (see pl. 4,B; also *A. phymatodes*, p. 90). Without specimens I am unable to determine if *A. güntheri* is distinct from *Phrynelox melas*.

Phrynelox nuttingi (Garman)

PLATE 3,D

Antennarius nuttingi Garman, Bull. Lab. Nat. Hist., State University of Iowa, vol. 4, p. 83, pl. 2, 1876 (type locality, Great Bahama Bank); Barbour, Proc. New England Zool. Club, vol. 19, pp. 25, 36, pl. 15, pl. 17, fig. 4, 1942 (Puerto Rico; Bermuda; Haiti; Great Bahama Bank).

This black species, with bifid tentacles (usually whitish) as bait, has a naked area behind base of second dorsal spine, last two or three soft dorsal rays and last pelvic ray divided; pectoral rays all simple; anal rays all divided; caudal peduncle distinct; tips of rays of paired fins usually not white, although in a few specimens there is a tendency for lighter tips to these rays.

While this manuscript was in press Dr. Louis A. Krumholz brought to the National Museum for identification two specimens of *Phrynelox* that he saw spawning together. One, the male, was the characteristically colored *P. scaber*, whereas the other, the female, was the typically black colored *P. nuttingi*. Dr. Krumholz had both males and females with the zebralike color pattern which is typical of *P. scaber*. Three black specimens examined by him were females. His observation

may indicate that the black "species" currently known as *P. nuttingi* represents mature females.

I have observed sexual dichromatism to be of rather common occurrence in several families of reef fishes; for example, the parrotfishes, family Scaridae. This problem needs special study in the field in the areas where the black "color phase" occurs, as it does with several other members of this family.

I have studied 11 specimens. From the U. S. National Museum (number of specimens in parentheses following the museum catalog number): 73115(1), Florida; 50199(1) and 25927(1), both from Puerto Rico. From the Chicago Natural History Museum (CNHM): 1 from off Texas and 6 from Bermuda. Dr. Louis A. Krumholz loaned a female from Bimini.

Phrynelox scaber (Cuvier)

PLATE 4,C,D

Chironectes scaber Cuvier, Mèm. Mus. Hist. Nat. Paris, vol. 3, p. 425, pl. 16, lower fig., 1817 (type locality, Atlantic); Le règne animal, edition of plates, vol. 2, pl. 85, fig. 1, 1839.—Cuvier and Valenciennes, Historie naturelle des poissons, vol. 12, p. 412, 1837 (Martinique).

?*Chironectes furcipilis* Cuvier, Mèm. Mus. Hist. Nat. Paris, vol. 3, p. 429, pl. 17, fig. 1, 1817 (no locality).—Cuvier and Valenciennes, Histoire naturelle des poissons, vol. 12, p. 423, 1837 (Atlantic).

?*Chironectes biocellatus* Cuvier, Mèm. Mus. Hist. Nat. Paris, vol. 3, p. 427, pl. 17, fig. 3, 1817 (no locality).—Cuvier and Valenciennes, Histoire naturelle des poissons, vol. 12, p. 417, 1837.

Chironectes tigris Poey, Memorias sobre la historia natural de la Isla de Cuba, vol. 1, p. 217, pl. 17, fig. 2, 1853 (type locality, Cuba).

Antennarius teleplanus Fowler, Proc. Acad. Nat. Sci. Philadelphia, p. 38, fig. 2, 1912 (type locality, Corson's Inlet, Cape May County, N. J.; type examined).

Antennarius cubensis Borodin, Bull. Vanderbilt Oceanogr. [Marine] Mus., vol. 1, art. 1, p. 24, pl. 3, fig. 1, 1928 (Puerto Padre, Cuba).

Antennarius tenebrosus (non Poey), Barbour, Proc. New England Zool. Club, vol. 19, p. 28, 1942 (Cuba).

Antennarius scaber Barbour, Proc. New England Zool. Club, vol. 19, pp. 26, 36, pl. 8, pl. 17, fig. 1, 1942 (Cuba; St. Lucia; Panamá; Florida, Bermuda; Jamaica).

Antennarius tigris Barbour, Proc. New England Zool. Club, vol. 19, pp. 26, 37, pl. 9, figs. 1, 2, pl. 17, fig. 2, 1942 (Jamaica; Cuba).

Barbour, in 1942, established a neotype (USNM 37545) for *Chironectes tenebrosus* Poey (Memorias sobre la historia natural de la Isla de Cuba, p. 219, pl. 17 (20), fig. 1, 1853) and then referred Poey's *tenebrosus* to the synonymy of *A. multiocellatus* (Cuvier and Valenciennes). Upon examination of USNM 37545, I find the specimen to be a typical example of *Phrynelox scaber*, with all the significant characters such as bait with bifid tentacles, and color pattern of young *scaber*.

This species, with bifid tentacles forming the bait, has a zebralike color pattern. The young, represented by *Antennarius tenebrosus* (non Poey) Barbour on USNM 37545, neotype, is marked with dark spots and blotches not yet formed into zebralike stripes. A naked area or pit occurs behind second dorsal spine; last 2 or 3 soft dorsal rays and last pelvic ray are divided; pectoral rays all simple; anal rays all divided; caudal peduncle distinct; Barbour considers *A. tigris* to be distinct from *A. scaber* on the differences in robustness of the tentacles. I am unable to find support for his observations on the numerous specimens available to me.

In addition to certain types, I have studied 36 specimens. From USNM: Neotype, *Chironectes tenebrosus* Poey, 37545(1), 2699(1), 37500(1), all from Cuba and all collected by Poey; 38531(1), Curaçao; 41709(1), St. Lucia; 30144(1), Jamaica; 81785(1), Porto Bello, Panamá; 81786(1) and 81780(1), both from Fox Bay, Panamá; 126076(1), Puerto Rico; 150053(1), Guadaloupe Island; 116762(2), Tortugas, Florida. From CNHM: 40296(1), 45698(3), 45699(2), 45700(3), 46746(1), 46747(1), 46748(1), and 59956(3), Gulf of Mexico; 17133(1) and 50353(1), Florida; 8549(2), Porto Bello, Panamá; 4852(1), 48511(1), 48541(1), 48603(1), 48604(1), 48633(1), and 48682(1), Bermuda. Dr. Louis A. Krumholz loaned a male from Bimini.

Triantennatus, new subgenus

Genotype: *Antennarius zebrinus*, new species.

This new subgenus is characterized by having three fleshy tentacles at the tip of the first dorsal spine. It has the last 2 or 3 soft dorsal rays and last pelvic ray divided. As in the subgenus *Phrynelox*, all pectoral rays are simple and all anal rays are divided.

The subgenus is named in reference to the first dorsal spine being provided with three fleshy tentacles.

Phrynelox cunninghami (Fowler)

Plate 5,a.

Antennarius cunninghami Fowler, Proc. Acad. Nat. Sci. Philadelphia, vol. 93, p. 279, fig. 32, 1941 (type locality, Oahu or Maui, Hawaii; holotype, ANSP 69892, 86 mm. in standard length).

This species has the first dorsal longer than second dorsal spine, and bears at its tip trifid tentacles; last 2 or 3 soft dorsal rays and last pelvic ray divided; all of pectoral rays simple; all of anal rays divided, caudal peduncle distinct.

I have studied the holotype of this species.

Phrynelox zebrinus, new species

FIGURE 3

Antennarius tridens (non Shaw) Bleeker, Atlas ichthyologique . . ., vol. 1, p. 14, pl. 195, fig. 3, 1865 (Amboina).

Antennarius striatus (non Shaw) Günther, Journ. Mus. Godeffroy, pt. 11, p. 162, pl. 99, fig. B, 1876 (Mauritius; Australian Coast; Solomon Islands).

Antennarius pinnaceps (non Shaw) Smith, The sea fishes of Southern Africa, p. 431, pl. 98, fig. 1239, 1949 (Natal and Delagoa Bay).

HOLOTYPE: USNM 47854, Port Jackson, New South Wales, Australia, standard length 96 mm.

PARATYPES: USNM 47853 and 59948, Port Jackson, New South Wales, respectively 89 and 93 mm. in standard length; USNM 28659, probably from Australia; CNHM 21560, Sydney, Australia, 92 mm.; CNHM 44980, Moreton Bay, South Queensland, Australia, 41.5 mm.

DESCRIPTION: Certain counts and measurements are recorded in tables 1 and 2.

The bony part of first dorsal spine, about same length as second dorsal spine, bears at its tip the fleshy bait, which is composed of three fleshy tentacles, the middle one shortest; behind the robust second dorsal spine is a naked dermal area; the third dorsal spine is movable, about same length as the second; all of the soft dorsal rays are simple except the last two which are divided, as is the last pelvic fin ray; caudal fin rays divided or branched; all of anal rays divided; pectoral

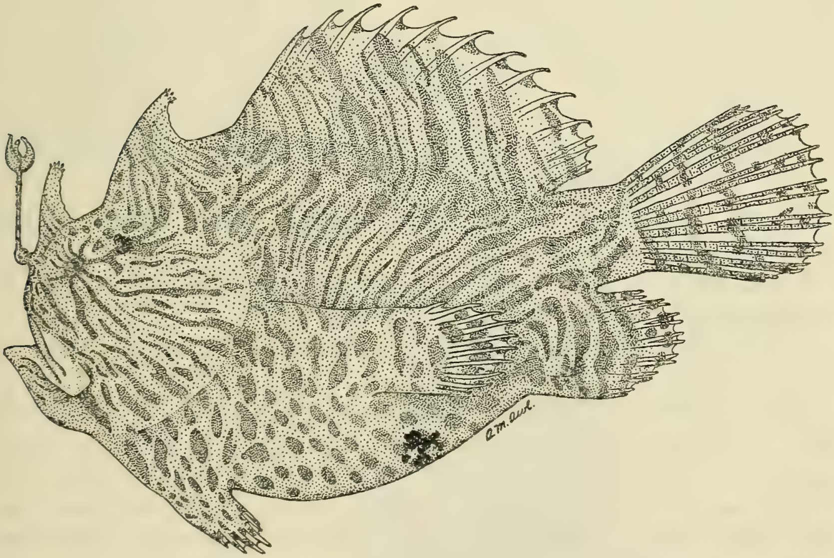

FIGURE 3.—*Phrynelox zebrinus*, new species. Drawing by Mrs. A. M. Awl of holotype, USNM 47854, from Port Jackson, New South Wales, Australia.

rays all simple; gill opening close to pectoral fin base; caudal peduncle distinct, a little deeper than long; skin thickly covered with bifid, sometimes trifid, prickles, and a few prickles on head are multifid; dermal cirri are scattered on body apparently in no definite arrangement except possibly along what may be a lateral line.

Color in alcohol: Background coloration light tan; sides and dorsally, including dorsal and anal fins, profusely covered with narrow, zebralike, dark brown streaks; pectoral, pelvic, and caudal fins barred and spotted with dark brown; belly below level of pectoral fin with scattered dark brown spots.

The dark brown, zebralike streaks apparently increase in number with increase in size, because the 41.5 mm. specimen has only 7 or 8 streaks on the dorsal fin and side of body, whereas the larger specimens have 15 or 20 such bars; narrow bars form between the wider ones as growth proceeds. Günther's plate 99, figure b, shows the belly striped, but all of our specimens have it spotted.

Remarks: Among the species with three tentacles forming the bait and with a zebralike color pattern, *A. cunninghami* Fowler is most closely related. The latter differs in the adult size in having a much fewer number of dark brown zebralike markings, only four or five dark bars instead of seven (young) to 20 or more on the soft dorsal fin; also, the belly of *cunninghami* is unspotted in the holotype.

This new species is named *zebrinus* in reference to the color pattern, which resembles that of a zebra.

Phrynelox atra, new species

Figure 4

Antennarius commersonii (non Cuvier; non Shaw) Whitley, Rec. Australian Mus., vol. 17, p. 137, pl. 31, fig. 5, 1929 (Port Jackson and Port Hacking, New South Wales).

Holotype: CNHM 21705, from Sydney, New South Wales, Australia, standard length 73 mm.

Paratypes: CNHM 21704 and USNM 164245, from Sydney, Australia, both 87 mm. in standard length.

Description: Certain counts and measurements are recorded in tables 1 and 2.

The bony part of the first dorsal spine, about the same length as that of the second dorsal spine, bears at its tip the fleshy bait, which consists of three robust tentacles, the middle one smallest; skin just behind base of second dorsal spine is naked; third dorsal spine movable posteriorly, bound down with skin anteriorly, and same length as second; soft dorsal rays all simple except last two are divided; only last pelvic ray divided; caudal fin rays branched; anal rays divided; pectoral rays all simple; gill opening close to base of pectoral fin;

TABLE 2.—*Measurements made on two new species of* Phrynelox (zebrinus *and* atra), *recorded in thousandths of the standard length*

Characters	*zebrinus*						*atra*		
	Port Jackson, New South Wales, Australia			Australia?	Sydney, Australia	Moreton Bay, Queensland, Australia	Sydney, New South Wales, Australia		
	USNM 47853 paratype	USNM 47854 holotype	USNM 59948 paratype	USNM 28659 paratype	CNHM 2156 paratype	CNHM 44980 paratype	CNHM 21704 paratype	CNHM 21705 holotype	CNHM 21707 paratype
Standard length in mm.	89	96	93	82	92	41.5	87	73	87
Greatest depth of body	562	594	613	574	571	518	575	549	575
Length of bony part of 1st dorsal spine	180	174	172	155	163	229	178	199	181
Length of bony part of 2d dorsal spine	146	146	156	146	180	169	184	185	172
Length of bony part of 3d dorsal spine	157	156	151	165	147	188	167	185	207
Longest soft dorsal ray	315	323	258	305	255	337	282	322	299
Longest (middle) caudal ray	337	344	285		327	422	253	343	332
Head (snout to gill opening)	640	604	567	610	635	622	667	644	644
Length of maxillaries	225	229	237		218	233	224	247	207
Least depth of caudal peduncle	146	151	161	140	136	145	121	137	127
Length of caudal peduncle or distance between vertical lines through caudal fin base and rear bases of anal-dorsal fins.	129	99	131	116	120	133	115	123	103
Length of base of soft dorsal fin	438	511	452	445	495	506	473	514	517
Eye diameter	52	42	48	48	59	72	57	52	46
Interorbital space	157	135	154	146	158	147	172	164	155
Dorsal rays	I-I-I-12	I-I-I-12	I-I-I-12	I-I-I-12	I-I-I-12	I-I-I-12	I-I-I-12	I-I-I-12	I-I-I-12
Anal rays	7	7	7	6	7	7	7	7	7
Pectoral rays	10-10	10-10	10-10	10-10	10-11	10-10	10-10	10-10	10-10

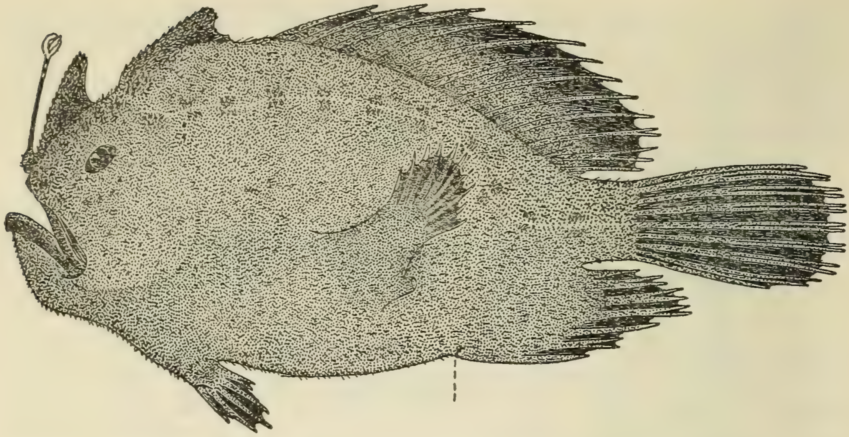

FIGURE 4.—*Phrynelox atra*, new species. Drawing of holotype, CNHM 21705, from Sydney Australia.

caudal peduncle distinct, slightly deeper than long; skin thickly covered with bifid prickles except a few trifid ones and some multifid prickles on head; dermal cirri present along what probably represents a lateral line, though it is not easy to follow, other cirri scattered on body.

COLOR IN ALCOHOL: Head, body, and fins all plain black; fleshy part of bait white or nearly so; tips of rays of pectoral and pelvics a little lighter than basally, sometimes almost whitish.

REMARKS: This new species, almost entirely blackish, resembles *Phrynelox nox* of Japan. It differs by having 10 pectoral fin rays instead of 11, and, in addition, the tips of the pectoral fin rays are scarcely lighter than basally. *P. nox* may have black spots on median and paired fins, usually distally, absent in *P. atra*. The bait is light brown in *P. nox* also.

This new species is named *atra* in reference to its black coloration.

Phrynelox nox (Jordan)

FIGURE 5

Antennarius nox Jordan, *in* Jordan and Sindo, Proc. U. S. Nat. Mus., vol. 24, p. 375, fig. 6, 1902 (type locality, Wakanoura and Nagasaki, Japan; cotype, USNM 49819).—Jordan, Tanaka, and Snyder, Journ. Coll. Sci., Tokyo Imp. Univ., vol. 33, art. 1, p. 424, fig. 392, 1913 (Japan).—Jordan and Thompson, Mem. Carnegie Mus., vol. 6, p. 313, fig. 87, 1914 (Misaki, Japan).

Antennarius tridens (non Temminck and Schlegel; in part) Tanaka, Figures and descriptions of the fishes of Japan, vol. 47, p. 929, pl. 186, figs. 509, 510, 1930 (Japan).

Antennarius fuliginosus J. L. B. Smith, South African Journ. Sci., vol. 53, No. 8, p. 222, fig. 5, 1957 (type locality, Durban, South Africa).

This species is characterized by its dark brownish to blackish coloration, along with trifid fleshy tentacles at tip of first dorsal spine; last 2 or 3 soft dorsal rays and last pelvic ray divided; anal rays all divided, pectoral rays all simple; caudal peduncle distinct; naked area behind second dorsal spine; black spots as large as or larger than the eye usually evident on head and body; tips of pectoral rays white; black spots may occur distally on all fins; first dorsal spine may be barred.

I have studied three specimens, all from Japan: From USNM: 49819(1) (the cotype) and 164192(1). From CNHM: 57440(1).

Phrynelox tridens **(Temminck and Schlegel)**

PLATE 5,B

Lophius histrio (non Linnaeus) Lacepède, Histoire naturelle des poissons, vol. 1, pp. 302, 321, 1798 (on Commerson; nonbinomial).

Chironectes tridens, Temminck and Schlegel, Fauna Japonica, poissons, p. 159, pl. 81, figs. 2–5, 1842 (type locality, Japan).

Antennarius pinniceps bleekeri Günther, Catalogue of the fishes in the British Museum, vol. 3, p. 190, 1861 (type locality, Amboina).

This species, with trifid tentacles forming the bait, has a characteristic pale background overlaid with zebralike dark brown or blackish streaks on the body and blackish spots on the median fins; the belly has dark brown spots also; there is a naked area behind the second dorsal spine, the last 2 or 3 rays of soft dorsal are branched, as is the last pelvic ray; anal rays all divided; pectoral rays all simple; caudal peduncle distinct; the color pattern of *tridens* is almost identical with

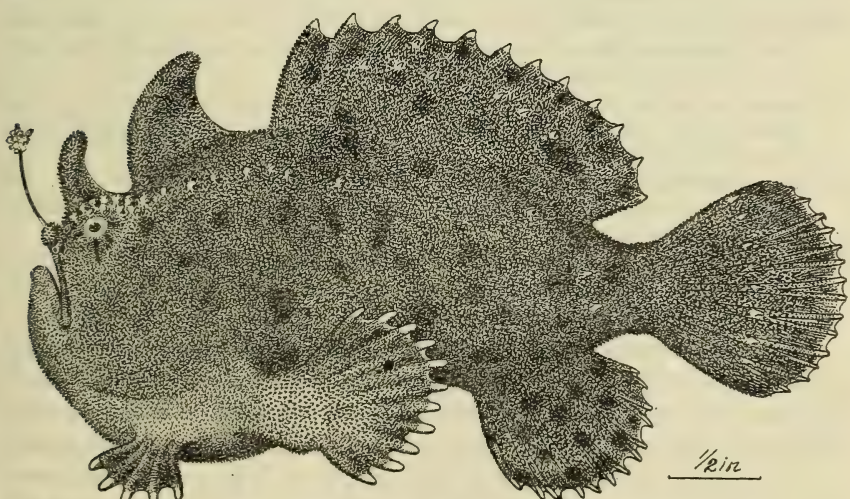

FIGURE 5.—*Phrynelox nox* (Jordan) *in* Jordan and Sindo. Drawing of cotype, USNM 49819 from Japan.

cunninghami but the two differ in number of pectoral rays—11 in *tridens* and 10 in *cunninghami*.

I have studied 35 specimens. From USNM: 49821(5), 50759(1), 57525(1), 59770(1), 59771(3), 72017(1), 72030(2), 75974(1), 76261(9), and 152540(1), all from Japan; 143564(4), Mauritius (locality very doubtful). From CNHM (loaned by Loren P. Woods): 55397(2), 55461(1), 58850(1), 57441(2), all from Japan.

Antennatus, new genus and new subgenus

GENOTYPE: *Antennarius strigatus* Gill.

The new genus and new subgenus are distinguished by the simple tentacle at tip of first dorsal spine in combination with the following characters: the head, body, and fins basally thickly covered with close-set prickles on firm skin; no distinct caudal peduncle; the third dorsal spine bound down with skin; and all the rays in soft dorsal and pelvic fins simple.

Antennatus bigibbus (Lacepède)

PLATE 5,C,D

Antennarius bigibbus Lacepède, Histoire naturelle des poissons, vol. 1, p. 325, pl. 14 upper fig., 1798 (type locality, "on Commerson").—Bleeker, Atlas ichthyologique, vol. 5, p. 21, pl. 199, fig. 3, 1865 (Cocos; Amboina).—Günther, Journ. Mus. Godeffroy, pt. 11, p. 165, 1876; pt. 13, pl. 105, fig. B, 1877 (Huahine).—Smith, The sea fishes of Southern Africa, p. 430, pl. 98, fig. 1235, 1949 (Natal).

?*Antennarius bivertex* Lacepède, Histoire naturelle des poissons, vol. 1, p. 327, 1798 (on Commerson).

Chironectes tuberosus Cuvier, Mem. Mus. Hist. Nat. Paris, vol. 3, p. 432, 1817 (on Commerson; Mauritius).—Cuvier and Valenciennes, Histoire naturelle des poissons, vol. 12, p. 428, 1837 (Mauritius).

Chironectes reticulatus Eydoux and Souleyet, Voyage autour du Monde . . . *La Bonite*, Zool., vol. 1, pt. 2, Poissons, p. 186, pl. 5, fig. 2, 1842 (type locality, Hawaiian Islands).

Chironectes leprosus Eydoux and Souleyet, Voyage autour du Monde . . . *La Bonite*, Zool. vol. 1, pt. 2, Poissons, p. 187, pl. 5, fig. 3, 1842 (type locality, Hawaiian Islands).

?*Chironectes subrotundatus* Castelnau, Philadelphia International Exhibition 1876; Intercolonial Exhibition Essays, No. 2, p. 25, 1876 (type locality, Port Walcott, Western Australia).

This species has a simple threadlike first dorsal spine and bait, the latter scarcely distinguishable from the spiny part; the body, head, and fins basally are thickly covered with close-set prickles so that the skin is firm; no naked area occurs behind the second dorsal spine; third dorsal spine bound down with skin, thus it is immovable; none of the soft dorsal or pelvic rays are branched; anal rays all branched; pectoral rays all simple; caudal peduncle absent or nearly so; background color pale, mottled or reticulated with brown; brown bar across

caudal, anal, and pelvic fins; pectoral brownish basally, sometimes with a series of brown spots distally.

I have studied nine specimens. From USNM: 65732(1), Fakarava, Tuamotu Islands; 109396(1), Palmyra Island; 126598(1), Honolulu; 164206(2), New Georgia Island, Solomons; 167511(1), Oahu. From CNHM: 47648(1), Hawaii. Loaned by Dr. R. R. Harry (2): Tuamotu Islands in the channel between Geogeo and Kukina islets near Garumaoa village (collected by Dr. Harry in 1952).

Antennatus strigatus (Gill)

PLATE 6,C

Antennarius strigatus Gill, Proc. Acad. Nat. Sci. Philadelphia, p. 92, 1863 (type locality, Cape San Lucas; 2 types, USNM 6267).

Antennarius tenuifilis Günther, Trans. Zool. Soc. London, vol. 6, pt. 7, p. 440, 1869 (type locality, reefs off Panama City, Panamá).

Antennarius reticularis Gilbert, Proc. U. S. Nat. Mus., vol. 14, p. 566, 1892 (type locality, Gulf of California; holotype, USNM 48260).

Antennarius ziesenhennei Myers and Wade, Allan Hancock Pacific Exped., vol. 9, No. 6, p. 168, pl. 23, fig. 7, 1946 (type locality, James Island, Galápagos).

This species is the eastern Pacific representative of *A. bigibbus*, but differs mostly in the number of pectoral fin rays being 9 or 10 instead of 11; body, head, and fins basally covered by shagreenlike, closely packed denticles; the simple first dorsal spine and bait is about as long as second dorsal spine, whereas in *bigibbus* it is longer; all soft dorsal, pectoral, and pelvic rays undivided; anal rays all divided; no naked area behind second dorsal spine; third dorsal spine bound down with skin, immovable; body mottled with blackish or dark brown, the blackish extending on the fins; a dark bar across caudal, anal, pelvic, and pectoral fins; membranes between rays distally edged with blackish; underside of head with dark blotches.

In addition to the types, I have studied 4 specimens. From USNM: 120208(1), Galápagos Islands; 101756(2), Gorgona Island, Colombia; 101757(1), Secas Island, Panamá.

Xenophrynichthys, new subgenus

GENOTYPE: *Antennarius cryptacanthus* Weber.

This new subgenus differs in having the three dorsal spines completely embedded and covered over with skin, whereas the generalized antennariids have the first two dorsal spines free and the third covered with skin in only a few species, otherwise it is more or less movable, sometimes free.

Named in reference to the unusual or strange embedded nature of the dorsal spines of this otherwise normal frogfish.

Antennatus cryptacanthus (Weber)

PLATE 6,B

Antennarius cryptacanthus Weber, Die Fische der *Siboga*-Expedition, p. 564, pl. 3, fig. 2, 1913 (type locality, Beo, Karakelang Island, and Pepela Bay, Rotti Island, East Indies).

The usual three dorsal spines are completely embedded beneath the rough skin in this species, a character not shared with any other species in the family. I have not seen this species. It is known only from the two type specimens.

Genus and subgenus *Lophiocharon* Whitley

Lophiocharon Whitley, Rec. Australian Mus., vol. 19, p. 104, pl. 15, fig. 1, 1933 (genotype, *Lophiocharon broomensis* Whitley=*Chironectes trisignatus* Richardson).

This genus and subgenus are characterized by having a simple tentacle at tip of first dorsal spine in combination with an indistinct caudal peduncle; all of the soft dorsal rays being branched or divided but no pelvic ray branched.

Lophiocharon caudimaculatus (Rüppell)

PLATE 6,A,D

Chironectes caudimaculatus Rüppell, Neue Wirbelthiere zu der Fauna von Abyssinien . . . , p. 141, pl. 33, fig. 2, 1835 (type locality, Red Sea).

Chironectes trisignatus Richardson, Ichthyology of the voyage . . . *Erebus* and *Terror*, pl. 9, fig. 1, 1844–1848 (no locality given).

Antennarius urophthalmus Bleeker, Natuurk. Tijdschr. Nederlandsch-Indië, vol. 2, p. 488, 1851 (type locality, Riouw).

Antennarius lindgreeni Bleeker, Natuurk. Tijdschr. Nederlandsch-Indië, vol. 8, p. 192, 1855 (type locality, Banka).

Antennarius caudimaculatus Bleeker, Atlas ichthyologique, vol. 1, p. 15, pl. 197, fig. 6, 1865 (Banka; Biliton; Bintang; Singapura).

Antennarius lithinostomus Jordan and Richardson, Bull. U. S. Bur. Fish., vol. 27, p. 286, fig. 12, 1908 (type locality, Cugo Island, Philippines).

Lophiocharon broomensis Whitley, Rec. Australian Mus., vol. 19, No. 1, p. 104, pl. 25, fig. 1, 1933 (type locality, Broome, West Australia).

This is one of the few species of antennariids with all the soft dorsal rays divided; the first dorsal spine is very long and threadlike with a simple tentacular-like bait; no naked area behind second dorsal spine; third dorsal spine movable; none of the pelvic or pectoral rays divided; all anal rays divided; caudal peduncle not distinct; the coloration is light gray, everywhere thickly covered with dark specks and irregularly shaped small dark blotches; caudal fin dark spots with white centers.

All specimens seen by me are like the one illustrated, USNM 164243. These have an indistinct caudal peduncle, the caudal fin

has white centered dark spots, and a dark blotch basally in soft dorsal fin. These specimens are like the figure of *Chironectes trisignatus* Richardson. Ruppell's plate 33, figure 2, of *C. caudimaculatus* is either in error in regard to the distinct caudal peduncle along with that of Bleeker's plate 197, figure 6, or two species are involved. It is possible that *horridus*, with a distinct caudal peduncle, was confused with *caudimaculatus* by authors.

I have studied six specimens. From USNM: 164243(1), Sandakan District, North Borneo; 164360, the Philippines. From CNHM (loaned by Loren P. Woods): 51865(1), 51866(2), 51874(1), all from Sandakan District, North Borneo.

Uniantennatus, new subgenus

Genotype: *Antennarius horridus* Bleeker.

This new subgenus is characterized by having a simple tentacle at tip of first dorsal spine in combination with a distinct caudal peduncle, and with only the last two or three soft dorsal rays branched or divided.

Named in reference to the tip of first dorsal spine being provided with a simple tentacle.

Lophiocharon tenebrosus (Poey)

Plates 7,a, 14,b

Chironectes tenebrosus Poey, Memórias sobre la historia natural de la isla de Cuba, p. 219, pl. 17, fig. 1, 1853 (type locality, Cuba).

Herewith is a redescription of this species based on a specimen kindly given to the National Museum by Dr. C. Richard Robins. The following counts were made: Dorsal I–I–I, 12; anal 7; pectoral 10–10; pelvics 5–5 (last ray divided); caudal 4+5.

The following characters are recorded in thousandths of the standard length, 78 mm. Greatest depth 635; length of bony part of first dorsal spine 269; of second dorsal spine 105, of third 231; longest soft dorsal ray 231; longest (middle) caudal ray 295; length of head (tip of snout to gill opening) 638; length of maxillaries 263; least depth of caudal peduncle 155; length of caudal peduncle (distance between vertical lines thru caudal fin base and rear of membranous base of anal and dorsal fins) 68; length of base of soft dorsal 481; eye diameter 73; interorbital space 106.

The bony part of first dorsal spine is 2½ times length of second dorsal spine; no filaments occur at tip of first dorsal spine, which is simple, slender, hairlike; second dorsal spine short, curved; third dorsal spine longer than second, curved, movable, but bound to body with skin; area behind base of second dorsal spine, partly naked; all soft rays of dorsal simple except last 2 are divided; anal and caudal

rays all divided; pectoral rays all simple; last pelvic ray divided; others simple; caudal peduncle present; body, head, and fins finely denticulate; skin firm.

Color in alcohol: Background light brown, mottled with yellow (bright yellow when alive); scattered ocellate black spots on body and median fins; small ocellate spots on pectoral fin; pelvics plain white; caudal peduncle yellow; tips of pectoral, caudal, soft dorsal and anal fins white; soft dorsal and anal with a broad yellow band submarginally

Dr. C. Richard Robins, University of Miami, Florida, kindly sent this specimen to me for identification and gave permission for its inclusion in this review. It was assigned USNM 174940 and has the following data: Miami, Key Biscayne, ocean side, north of lighthouse, Oct. 15, 1956, collector Durbin Tabb, standard length 78 mm., total length 100 mm.

Barbour (Proc. New England Zool. Club, vol. 19, p. 28, 1942) designated USNM 37545 as the neotype of *Chironectes tenebrosus* Poey and then referred it to the synonymy of *A. multiocellatus* (Cuvier and Valenciennes). Both of these actions were in error zoologically. USNM 37545 is a typically young specimen of *A. scaber* (Cuvier). Furthermore, Barbour's action was unsound nomenclatorially because neotypes were without official standing until the "Copenhagen decisions on Zoological Nomenclature," 1953. Since Barbour's designation of the neotype does not fulfill the provisions established for neotypes, I herewith reject it.

Poey's figure shows first dorsal spine longer than second; all fin rays are illustrated as simple except in caudal fin and probably last pelvic ray; caudal peduncle distinct. Doubt must be cast on the accuracy of soft dorsal and of anal rays in regard to the details of branched or not.

Lophiocharon horridus (Bleeker)

PLATE 7,B

Antennarius horridus Bleeker, Natuurk. Tijdschr. Nederlandsch-Indië, vol. 5, p. 83, 1853 (type locality, Solor); Atlas ichthyologique, vol. 5, pl. 194, fig. 1, 1865 (Cocos; Celebes; Flores; Solor; Timor; Buro; Amboina; and Ceram).

?*Antennarius lutescens* Seale, Occ. Pap. Bishop Mus., vol. 4, p. 89, fig. 2, No. 1347 on p. 14, 1906 (type locality, Tahiti).

Antennarius lateralis Tanaka, Zool. Mag., vol. 29, No. 345, p. 200, 1917 (type locality, Tanabe, Province Kii, Japan); Figures and descriptions of the fishes of Japan, vols. 27, 28, p. 494, pl. 135, fig. 378, 1918. (Tanabe, Japan).

Lophiocharon goramensis (non Bleeker) Whitley, Australian Zool., vol. 10, pt. 1, p. 45, pl. 2, fig. 29, 1941 (off Cairns, North Queensland, Australia).

Antennarius commersoni Smith, The sea fishes of southern Africa, p. 430, pl. 98, fig. 1236, 1949 (Natal).

This species has the first dorsal spine long and slender with a simple tentacle forming the bait; last two or three soft dorsal rays and

the last pelvic ray divided; pectoral rays all simple; anal rays all divided; caudal peduncle distinct; naked area behind second dorsal spine; general coloration dark brown, spotted or speckled with blackish, and some ocellate spots present; Tanaka shows the distal edges of median fins pale. The above characters along with 12 or 13 soft dorsal rays, 8 or 9 anal rays, and 10 to 12 pectoral rays should aid in recognizing this species.

The only specimen that I have seen that could be assigned to *horridus* is USNM 19991, probably from Mauritius, but the bait is missing and the specimen is in imperfect condition. It has the following counts: dorsal soft rays 12, anal 8, and pectoral 11–11.

***Lophiocharon campylacanthus* (Bleeker)**

PLATE 7,C

Antennarius campylacanthus Bleeker, Nat. Verh. Hollandaise Maatsch. Wetensch. Haarlem, vol. 18, No. 2, p. 28, pl. 4, fig. 3, 1863 (type locality, Ashantee, Guinea, West Africa).

I have not seen a specimen of this species. Bleeker's figure shows the last three soft dorsal rays divided, none of the pelvic or pectoral rays divided; anal rays all divided; caudal peduncle distinct; no naked area behind second dorsal spine; the dark colored body has three large ocellate spots on the side, and each median fin with a few large ocellate spots. The very short, simple first dorsal spine shorter than the second dorsal spine is an important character.

Genus *Antennarius* Lacepède

Antennarius (Commerson MS.) Lacepède, Histoire naturelle des poissons, vol. 1, p. 325, 1798 (genotype: *Antennarius chironectes* (Commerson) Lacepède (= *Lophius commersoni* Shaw 1804 and authors), designated by Bleeker (Atlas ichthyologique, vol. 1, p. 5, 1865)).

Chironectes Cuvier, Mem. Mus. Hist. Nat. Paris, vol. 3, p. 418, 1817 (genotype, *Lophius chironectes* (Commerson) Lacepède).

Batrachopus Goldfuss, Handbuch der Zoologie, vol. 2, pt. 3, p. 110, 1820. (Proposed to replace *Chironectes* Cuvier 1817, no species listed, *Histrio* Linnaeus is listed) [Obviously author is confused.]

Capellaria Gistel, Naturgeschichte des Thierreichs, p. viii, 1848. (Subs. name for *Chironectes*, no species listed.)

This genus is characterized by having a complex bait consisting of a tuft of tentacles or a bulbous bait with or without obvious tentacles, all anal rays branched, in combination with the last two or three soft dorsal rays divided or none of dorsal rays divided; the caudal peduncle is distinct or indistinct.

Among the numerous species assigned to this genus, certain groups of species indicate divergent lines of evolution.

Subgenus *Fowlerichthys* Barbour

Fowlerichthys Barbour, Proc. New England Zool. Club, vol. 19, p. 12, pl. 7, 1941 (genotype, *Fowlerichthys floridanus* Barbour = *Antennarius radiosus* Garman).

This subgenus is characterized by having a tuft of tentacles or a bulbouslike bait with filaments in combination with a distinct caudal peduncle, all soft rays, except possibly first two or three, of dorsal are divided; pelvic rays all divided.

Fowlerichthys floridanus Barbour (Proc. New England Zool. Club, vol. 19, p. 12, 1941) presents a difficult problem as regards the genus and species to which the type is related. Although the late Dr. Barbour thought the holotype was close to the genus *Chaunax*, I disagree because: (1) The dermal denticles are like those in *Antennarius;* (2) since the type is badly eroded, that which remains resembles other eroded specimens of *Antennarius* that I have examined, leaving exposed dorsal spines, no bait, and only stubs for most of the fin rays; (3) the generic allocation in the family Antennariidae is difficult because of the incomplete condition of the type. However, those characters remaining do help in forming an opinion as follows: (a) the bait is missing, but the presence of the little bony knob from which it always arises is present, indicating that the bait was lost through erosion, probably in the dredge in which collected; (b) the caudal peduncle is distinct, as the last rays of dorsal and anal fins are far in front of caudal fin base; (c) the dorsal spines project because the skin that covered them has eroded away; and (d) the first three pelvic rays are said to be branched, but in all other species of this family if the first three pelvic rays were branched all pelvic rays were branched.

The above characters, along with general shape of body indicates without doubt that *F. floridanus* belongs to the genus *Antennarius*. Among all Atlantic species in the family Antennariidae, only three—*Antennarius radiosus*, *A. ocellatus*, and *Kanazawaichthys scutatus*, new species—have 13 pectoral fin rays. Since bony scutes are absent on the head of *F. floridanus* it is not close to *K. scutatus*. Since *A. ocellatus* usually has 12 pectoral, 8 anal, and 13 soft dorsal rays, it is improbable that *floridanus* is the same as *ocellatus*.

If the pelvic rays of *F. floridanus* are all branched, as I suspect they are, then it would belong to the same subgenus with *radiosus*, and is no doubt a synonym of that species.

Doubt must be cast on the depth of capture of 400 to 500 fathoms since the fish might have gotten in the dredge when it was being hauled to the surface.

Antennarius radiosus Garman

PLATE 7,D

Antennarius radiosus Garman, Bull. Lab. Nat. Hist. State Univ. Iowa, vol. 4, No. 1, p. 85, pl. 1, 1876 (type locality, Key West, Fla., and Havana, Cuba).—Barbour, Proc. New England Zool. Club, vol. 19, pp. 31, 38, pl. 16, fig. 1, pl. 17, fig. 3, 1942 (Florida; Bermuda).

Fowlerichthys floridanus Barbour, Proc. New England Zool. Club, vol. 19, p. 12, pl. 7, 1941 (type locality, off Palm Beach, Fla.).

This is one of the most frequently captured species of *Antennarius* in the vicinity of Florida and along the northern part of the Gulf of Mexico. *A. radiosus* is best characterized by the first dorsal spine being a little longer than the second and bearing at its tip a small compact bulbous bait with short filaments; along with 8 anal rays and usually 13, sometimes 14, pectoral rays; all the soft dorsal, anal, and pelvic rays are divided; pectoral rays all simple; a naked area occurs behind second dorsal spine; caudal peduncle distinct; third dorsal spine movable; coloration generally brown or grayish, somewhat mottled; median fins barred; a characteristic ocellate spot occurs near bases of soft dorsal rays 8 to 10, a little more on body than on base of fin.

I have studied 103 specimens from USNM: 30210(1), Pensacola, Fla.; 134251(1), off Pensacola, Fla.; 116761(15), Tortugas, Fla.; 129814(1) and 131615(2), Key West, Fla.; 142894(9) and 148521(4), near Apalachiola, Fla.; 152222(1), 153142(1), 153143(1), 153144(3), 153145(4), 153225(3), and 161369(1), Palm Beach, Fla.; 131644(1), 143163(2), 120195(1), Gulf of Mexico; 153141(1), Sombrero Light, Fla.; 101585(1), 101586(1), and 101509(2), off Florida; 123505(1), 133649(7), 155479(2), 155481(2), 155483(2), 155486(1), 155487(4), 155488(3), 163984(4), 163985(4), and 162594(1), off Louisiana; 151925(1) off Salvo, N. C.; 155480(1), 155484(1), 155485(5), and 163986(2), off Mississippi; 155482(1), 155489(1), 155490(2), and 155491(2), off Texas; 155492(1) and 155493(1) off Savannah, Ga. In addition I have studied numerous specimens in 25 lots from the Gulf of Mexico loaned by the Chicago Natural History Museum.

Antennarius avalonis Jordan and Starks

FIGURE 6

Antennarius avalonis Jordan and Starks, Proc. U. S. Nat. Mus., vol. 32, p. 76, 1907 (type locality, Avalon Bay, Santa Catalina Island, Calif.).

Antennarius sanguineus (non Gill) Meek and Hildebrand, Field Mus. Nat. Hist. Pub. No. 249, Zool. Ser., vol. 15, pt. 3, p. 1013, 1928 (Panamá)—Hildebrand, U. S. Nat. Mus. Bull. 189, p. 501, 1946 (San Lorenzo Island, Perú).

This species is characterized by the first dorsal spine being shorter than the second, the bait in the form of a filamentous bulb; soft dorsal, anal, and pelvic rays all divided; most or all of pectoral rays

FIGURE 6.—*Antennarius avalonis* Jordan and Starks. Drawing of type retouched by author.

divided (in small to half grown specimens the divided rays may need the skin removed on one side before the branched condition of the ray can be seen); naked area behind second dorsal spine; third dorsal spine movable; caudal peduncle distinct. Coloration of brownish reticulations and dark brown spots on fins and body, a distinct ocellate spot on soft dorsal at bases of rays 9 to 11.

This species has been generally misidentified as *sanguineus* (for example, all specimens recorded below from Panamá by Meek and Hildebrand, "The Marine Fishes of Panama"). I have studied 23 specimens. From USNM: 82694(1), 81779(3), and 81787(1), all from Panamá; 144727(2) and 144726(11) from Guaymus, México; 128237(1), San Lorenzo Island, Perú. From CNHM: 8547(3) and 8548(1) from Panamá.

Antennarius sarasa **Tanaka**

PLATE 8,A

Antennarius sarasa Tanaka, Zool. Mag., vol. 28, No. 330, p. 143, 1916 (type locality, Tokyo Market); Figures and descriptions of the fishes of Japan, vol. 25, p. 432, pl. 119, fig. 346, 1916 (Tokyo Market).

This species, with first dorsal spine shorter than second, may have all the soft dorsal and anal rays divided, but Tanaka's drawing shows only the last eight dorsal rays divided; probably all of the pelvic rays are divided; third dorsal spine movable; caudal peduncle distinct.

This species is known from Tanaka's description and figure. I have not seen a specimen.

Antennarius ocellatus (Bloch and Schneider)

PLATE 8,B

Lophius histrio var. *ocellatus* Bloch and Schneider, Systema ichthyologiae, p. 142, 1801, on Parra, pl. 1, 1787).

Chironectes ocellatus Cuvier and Valenciennes, Histoire naturelle des poissons, vol. 12, p. 419, 1837 (Cuba).

Antennarius pleurophthalmus Gill, Proc. Acad. Nat. Sci. Philadelphia, p. 92, 1863 (type locality, Charlotte Harbor, Fla., not Key West; holotype, USNM 5886).

Antennarius astroscopus (non Nichols) Fowler, Proc. Acad. Nat. Sci. Philadelphia, vol. 92, pp. 19, 21, fig. 37, 1940 (Boca Grande, Fla).

Antennarius ocellatus Barbour, Proc. New England Zool. Club, vol. 19, pp. 30, 38, pl. 12, pl. 17, fig. 6, 1942 (Florida; Puerto Rico; Louisiana; Mississippi; Yucatan; South Carolina).

This species has the first dorsal spine a little shorter than the second dorsal spine; the third dorsal spine movable; bait consists of a filamentous bulb; area behind second dorsal naked except in large adults, about 140 mm. and longer; all the anal, soft dorsal, pelvic, and pectoral rays are divided; caudal peduncle distinct; background color light brown to brown, darker dorsally, overlaid with somewhat scattered dark brown dots or small spots; a large ocellate spot occurs basally on dorsal soft rays 7 to 9 and one on lower side of body over anal fin origin; another may or may not occur on middle of caudal fin.

I have studied 17 specimens. From USNM: 4545(1) and 4546(1), unknown localities; 5886(1) (holotype of *A. pleurophthalmus* Gill); 73114(1), Puerto Rico; 143181(1), 33001(1), 125386(1), 119310(1), 124280(2), 153234(2), 155478(1), all from both coasts of Florida; 155477(1) off Wilmington, N. C.; 163947(1) Spanish Wells, Bahamas. From CNHM: 45696(1), 59957(1), and 59958(1), all from Gulf of Mexico.

Plumantennatus, new subgenus

GENOTYPE: *Antennarius asper* Macleay.

This subgenus is characterized by having a plumelike bait, caudal peduncle absent, and all the soft dorsal rays divided but all the pelvic rays simple.

Antennarius asper Macleay

PLATE 8,C

Chironectes caudimaculatus (non Rüppell) Richardson, Ichthyology of the voyage . . . *Erebus* and *Terror*, p. 125, pl. 60, figs. 8, 9, 1844–1848 (Australia).

Antennarius asper Macleay, Proc. Linn. Soc. New South Wales, vol. 5, p. 580, 1881 (type locality, Darnley Island, Australia).—Whitley, Australian Zool., vol. 10, pt. 1, p. 46, pl. 2, fig. 30, 1941 (Murray Island).

This species has the first dorsal spine longer than the second, the bait consists of a broad ribbonlike tentacle with filaments basally, and

some distally; all of the soft dorsal and anal rays are divided but no pelvic or pectoral rays divided; no naked area behind base of second dorsal spine; caudal peduncle absent; coloration consists of a pale background, but profusely covered with small blackish spots or oblong small blotches, even on all fins; the caudal fin has three cross rows of hyaline spots encircled with a blackish line; at base of soft dorsal rays 7 to 9 is an ocellate spot with an unusually wide white area; distally the dorsal fin is broadly white-edged.

I have studied two specimens: USNM 164194 from Woods Inlet, West of Darwin, collected by Robert R. Miller, and CNHM 47248, from Singapore. The latter specimen is black all over, except distal edges of all median fins and tips of rays of paired fins are pale.

Subgenus *Antennarius* Lacepède

This subgenus is characterized by having only the last two or three soft dorsal rays divided; none or only the last pelvic ray divided; pectoral rays all simple; anal rays all divided, except possibly first is simple.

Antennarius phymatodes Bleeker

PLATE 11,A

Antennarius phymatodes Bleeker, Acta Soc. Sci. Indo-Neerlandicae, vol. 3, p. 69, 1857 (type locality, Amboina); Atlas ichthyologique, vol. 5, p. 11, pls. 197, fig. 1, and pl. 199, fig. 5, 1865 (Amboina).

This species was distinguished by Bleeker on the basis of "warts" on the skin. His figure does not show any of the rays branched except those of the caudal fin. This, in my opinion, would place *phymatodes* as a distinct species.

Dr. Robert R. Harry kindly loaned his Ifaluk Atoll collection of antennariids, and one specimen, 26.5 mm. in standard length with "warts" on the skin, agrees with *phymatodes* in not having any fin rays branched except those of the caudal. The color pattern has almost faded in the Ifaluk specimen and differs from *phymatodes* by lacking black spots. This might be caused by its small size, and until more material is available it is not good ichthyology to describe his specimen as new.

Antennarius hispidus (Bloch and Schneider)

PLATE 8,D

Lophius hispidus Bloch and Schneider, Systema ichthyologiae, p. 142, 1801 (type locality, Indian Ocean).

Chironectes lophotes Cuvier, Mem, Mus. Hist. Nat. Paris, vol. 3, p. 428, pl. 17, fig. 2, 1817 (no locality).

Chironectes hispidus Cuvier and Valenciennes, Histoire naturelle des poissons, vol. 12, p. 407, 1837 (East Indies).

Antennarius hispidus Bleeker, Atlas ichthyologique, vol. 5, p. 14, pl. 194, fig. 2, pl. 197, fig. 1, 1865 (Singapura; Ceram, Amboina).—Günther, Journ. Mus. Godeffroy, pt. 11, p. 162, pl. 99, fig. A, 1876 (Misol).
Antennarius scriptissimus Jordan, *in* Jordan and Sindo, Proc. U. S. Nat. Mus., vol. 24, p. 373, fig. 4, 1902 (type locality, Boshu, Tokyo Bay, Japan).
Antennarius tridens (non Temminck and Schlegel, in part) Tanaka, Figures and descriptions of the fishes of Japan, vol. 47, p. 929, pl. 186, fig. 508, 1930 (Japan).
Antennarius hispidus, Smith, The sea fishes of southern Africa, p. 430, p. 98, fig. 1234, 1949 (South to Knysna).

This species, with the first dorsal spine about the same length as the second dorsal spine, has for the bait a large tuft of filaments; second dorsal spine movable; only the last two, possibly last three, soft dorsal rays are divided; last pelvic ray divided; all anal rays divided; pectoral rays all simple; caudal peduncle distinct; naked area behind second dorsal spine; background coloration pale or light tan, overlaid with zebralike brown streaks, the pale interspaces 2 to 4 or more times wider than the narrow brown streaks; all fins with dark brown or blackish spots.

I have studied four specimens, all from the Philippines. From USNM: 56284(1), 56314(1), and 164361(1). From CNHM: 47095(1).

Antennarius moluccensis Bleeker

PLATE 9,A,C

Chironectes commersoni (non Shaw 1804) Cuvier, Mem. Mus. Hist. Nat. Paris, vol. 3, p. 431, pl. 18, fig. 1, 1817 (type locality, Sea of the Indies); Cuvier and Valenciennes, Histoire naturelle des poissons, vol. 12, p. 426, 1837 (on Cuvier, 1817).
Antennarius moluccensis Bleeker, Natuurk. Tijdschr. Nederlandsch-Indië, vol. 8, p. 414, 1855 (type locality, Amboina); Atlas ichthyologique, vol. 5, p. 17, pl. 196, fig. 2, 1865 (Amboina; Celebes).
Antennarius goramensis Bleeker, Nederlandsch Tijdschr. Dierk., vol. 2, p. 177, 1865 (type locality, Goram); Atlas ichthyologique, vol. 1, p. 17, pl. 195, fig. 2, 1865 (Goram).

Dr. de Beaufort has examined the types of *commersoni* Cuvier 1817, *moluccensis* Bleeker 1855, and *goramensis* Bleeker 1865 and finds them to represent the same species.

This species is known from large specimens only; has a long slender first dorsal spine, with a slender filamentous tentacle, no naked area behind second dorsal spine, third dorsal spine movable; last two rays of soft dorsal and last pelvic ray divided; anal rays all divided; pectoral rays all simple; caudal peduncle distinct but the anal fin is membranously attached to peduncle notably much farther back than that of dorsal fin; coloration light brown or reddish brown, everywhere spotted or blotched with brown; ocellate spots occur at middle of length of base of anal fin, at bases of soft dorsal rays 7 to 9, and an

ocellate spot on midside of body; these spots have broken up to form a block of smaller spots on the 215 mm. specimen.

I refer to this species with some doubt, two specimens, USNM 32507 from ?"California," 80 mm. in standard length, 108 mm. total length, and USNM 81061, Panama City Market, 215 mm. standard length, 255 total length, recorded by Meek and Hildebrand as *A. strigatus*. These two specimens cannot be confused with *A. sanguineus* because the latter has the first dorsal spine about the same length as the second and a different color pattern.

Dr. John Randall sent a Kodachrome transparency of a 230 mm. specimen taken at Oahu which is intermediate in color pattern between the two illustrations of this species. When alive the specimen was mottled dark brown and bright pink. A specimen captured by him was sent to me and he states that when alive it was "solid bright yellow." Another specimen measuring 195 mm. in standard length was "light yellowish brown" profusely speckled with tiny brown spots. All these specimens (USNM 167508, 167509) came from Oahu.

The speckled and mottled color patterns each may represent different sexes, but I was unable to determine the sex of the specimens.

Antennarius leucosoma Bleeker

Plate 9,b

Antennarius leucosoma Bleeker, Nat. Tijdschr. Nederlandsch-Indië, vol. 6, p. 328, 1854 (type locality, Flores); Atlas ichthyologique, vol. 5, p. 19, pl. 199, fig. 2, 1865 (Flores; Amboina).

Antennarius multiocellatus leucosoma Günther, Catalog of the fishes in the British Museum, vol. 3, p. 195, 1861 (Amboina and Flores). [Dr. de Beaufort examined Günther's specimen and kindly writes that it is "identical with Bleeker's type in the Leiden Museum."]

Antennarius multiocellatus var. *b.*, Playfair, Proc. Zool. Soc. London, p. 862, 1867 (Seychelles).

This species has a long slender first dorsal spine, much longer than second dorsal spine; bait a tuft of filaments; a movable third dorsal spine; last two rays of soft dorsal divided; no pectoral or pelvic ray divided; anal rays all divided; no naked area behind second dorsal spine and a distinct caudal peduncle; the whitish background color, everywhere profusely marked with tiny black dots, distinguishes this species from all others. I have not seen a specimen of *leucosoma*.

Antennarius pardalis (Cuvier and Valenciennes)

Plate 9,d

Chironectes pardalis Cuvier and Valenciennes, Histoire naturelle des poissons, vol. 12, p. 420, pl. 363, 1837 (type locality, Gorée [at Dakar, West Africa]).

This species is known from the description and figure of Cuvier and Valenciennes. Their illustration shows all the soft dorsal, pectoral,

and pelvic rays as simple or undivided and all anal rays divided; first dorsal spine longer than second; third movable; caudal peduncle distinct; color dark red, liberally spotted with black and with a few ocellate spots on median fins.

Antennarius chironectes Lacepède

PLATE 10,A,B

Anternnarius chironectes Lacepède, Histoire naturelle des poissons, vol. 1, p. 325, pl. 14, middle fig. 2, 1798 (on Commerson).—Bleeker, Atlas ichthyologique, vol. 5, p. 13, pl. 200, fig. 3, 1865 (Amboina; Banda).

Lophius commersoni Shaw, General zoology or systematic natural history, vol. 5, pt. 2, p. 387, 1804 (type locality, on Commerson in Indian Seas).

Chironectes variegatus Cuvier and Valenciennes, Histoire naturelle des poissons, vol. 12, p. 422, 1837 (on Lacepède; on Commerson).

Lophius sandvicensis Bennett, Narrative of a whaling voyage round the globe . . . , vol. 2, p. 258, fig., 1840 (type locality, Oahu).

?*Chironectes peravok* Montrouzier, Ann. Soc. Agr. Sci. Ind. Lyon, ser. 2, vol. 8, p. 467, 1856 (type locality, Woodlark Island).

Chironectes rubrofuscus Garrett, Proe. California Acad. Nat. Sci., vol. 3, p. 64, 1863 (type locality, Hawaiian Islands).

Chironectes niger Garrett, Proc. California Acad. Nat. Sci., vol. 3, p. 107, 1864 (type locality, Hawaiian Islands).

Antennarius commersoni Bleeker, Atlas ichthyologique, vol. 5, p. 20, pl. 197, fig. 3, 1865 (Ambonia; Ceram).

Antennarius polyophthalmus Bleeker, Natuurk. Tijdschr. Nederlandsch-Indië, vol. 3, p. 644, 1852 (type locality, Banda); Atlas ichthyologique, vol. 5, p. 12, pl. 197, fig. 4, 1865 (Banda; Goram).

Antennarius nigromaculatus Playfair, Proc. Zool. Soc. London, p. 239, 1869 (type locality, Zanzibar).

Antennarius commersoni Günther, Journ. Mus. Godeffroy, pt. 11, pp. 163, 164, pl. 100, figs. B, C, 1876; pt. 13, pls. 101, 102, fig. A, pl. 104, fig. A, pl. 106, fig. B, pl. 105, fig. A, 1877 (Raiatea; Huahine; Hawaiian Islands; Schiffer Island; Bonham Island).

Antennarius commersoni var. *nigromaculatus* Günther, Journ. Mus. Godeffroy, pt. 11, p. 163, 1876; pt. 13, pl. 102, fig. B, 1877 (Zanzibar).

Antennarius commersoni var. *niger* Günther, Journ. Mus. Godeffroy, pt. 11, p. 163, 1876; pt. 13, pl. 103, figs. A, B, 1877 (Hawaiian Islands).

Antennarius commersoni var. *rubrofuscus*, Günther, Journ. Mus. Godeffroy, pt. 11, p. 164, 1876; pt. 13, pl. 106, fig. A, 1877 (Hawaiian Islands).

Antennarius commersoni Günther, Journ. Mus. Godeffroy, p. 164, pt. 13, pl. 104, fig. B, 1877 (Society Island). [This plate shows only 7 pectoral rays, which is most unusual for a species of *Antennarius*; the only other known species having only 7 pectoral rays is *Tathicarpus butleri*. Otherwise pl. 104, fig. B resembles *A. chironectes* as recognized here. I think the drawing to be in error, and until a specimen is available a new name should not be assigned to the drawing.]

Antennarius argus Fowler, Proc. Acad. Nat. Sci. Philadelphia, vol. 55, p. 172, pl. 8, 1903 (type locality, Zanzibar; holotype ANSP 24208, examined by me).

Antennarius laysanius Jordan and Snyder, Proc. U. S. Nat. Mus., vol. 27, p. 947, 1904 (type locality, Laysan Island).—Jordan and Evermann, Bull. U. S. Fish Comm., vol. 23, pt. 1, p. 520, pl. 63, 1905 (Laysan Island).

Antennarius leprosus (non Eydoux and Souleyet) Jordan and Evermann, Bull. U. S. Fish Comm., vol. 23, pt. 1, p. 519, fig. 228, 1905 (Honolulu).

Antennarius commersoni var. *nigromaculatus* Steindachner, Sitzber. Akad. Wiss. Wien, vol. 115, pt. 1, p. 1413 [reprint p. 45], 1906 (on Günther, Fische der Südsee, pl. 102, fig. A, 1877).

Antennarius polyophthalmus, Smith, The sea fishes of southern Africa, p. 431, pl. 98, fig. 1242, 1949 (Delagoa Bay).

Antennarius glauerti Whitley, Western Australian Nat., vol. 5, No. 7, p. 207, fig., 1957 (type locality, Exmouth Gulf, Western Australia).

The smaller specimens of this species have a naked area behind base of second dorsal spine that becomes completely denticulate in the largest adults, over 200 mm. total length. This latter condition is represented by *A. laysanius* Jordan and Snyder and *A. chironectes* of Bleeker.

This species is widely distributed and variable in color pattern. The first dorsal spine is much longer than second dorsal spine, the third is movable; bait usually consists of a long ribbonlike tentacle and filaments; last two or three soft dorsal rays divided as is the last pelvic ray; anal rays all divided; pectoral rays all simple; caudal peduncle distinct. Color pattern may be black with tips of rays white, or a pale background with a few ocellate spots and scattered blackish spots on body, usually occurring rather constantly on the belly.

I have studied six specimens. From USNM: 63626(1), 75839(1), 89791(1), 92277(1), 126508(1), all from the Hawaiian Islands; 125961(1), Apia.

Antennarius multiocellatus (Cuvier and Valenciennes)

PLATE 10,C

Chironectes multiocellatus Cuvier and Valenciennes, Histoire naturelle des poissons, vol. 12, p. 420, 1837 (type locality, Martinique).

Chironectes mentzelii Cuvier and Valenciennes, Histoire naturelle des poissons, vol. 12, p. 147, 1837 (on a manuscript by Mentzel).

Chironectes principis Cuvier and Valenciennes, Histoire naturelle des poissons, vol. 12, p. 416, 1837 (on a manuscript by Mentzel).

Antennarius annulatus Gill, Proc. Acad. Nat. Sci. Philadelphia, p. 91, 1863 (type locality, Garden Key, Fla.; holotype, USNM 4849).

Antennarius corallinus Poey, Repertorio físico natural de la Isla de Cuba, p. 188, 1865 (type locality, Cuba).

Antennarius stellifer Barbour, Bull. Mus. Comp. Zool., vol. 46, No. 7, p. 132, pl. 4, 1905 (type locality, Castle Harbour, Bermuda).

Antennarius astroscopus Nichols, Bull. Amer. Mus. Nat. Hist., vol. 31, art. 11, pp. 109–111, fig. 1, 1921 (type locality, Barbados).

Antennarius multiocellatus Barbour, Proc. New England Zool. Club, vol. 19, pp. 27, 37, pls. 10, 11, 13, 14, 16 (fig. 2), 17 (fig. 5), 1942 (Gulf Stream; Bahamas; Florida; Cuba; Bermuda; Yucatan; Barbados).

This species has the first dorsal spine slender and much longer than the second dorsal spine, the former bears at its tip the filamentous bait; third dorsal spine movable; sometimes none but usually last

two soft dorsal rays divided, last pelvic ray divided; anal rays all divided; pectoral rays all simple; naked area behind second dorsal spine; caudal peduncle distinct.

There are two color-phases, one has a pale or light brownish background with black ocellate spots located in characteristic places as follows: basally on middle of anal fin; basally on soft dorsal rays 8 to 10; black spot each side of base of third dorsal spine; a few smaller black spots on caudal, dorsal, and pectoral fins; sides of body with several small scattered black spots; belly unspotted; a whitish or pale saddle on dorsal edge of caudal peduncle, especially notable in blackish color-phase. The blackish color-phase, in addition to the white peduncular spot, has one at rear of head, a small one on side just behind head, and another one at rear corner of mouth; the black spots may show as deeper black through the background color.

The shorter first dorsal spine, more numerous pectoral fin rays, and large ocellate spot on side of body of *A. ocellatus* distinguishes that species from *multiocellatus*.

I have studied eight specimens. From USNM: 4849, holotype of *A. annulatus* Gill; 39898 (1), Bahamas; 107351(1), Cuba; 116760(1), and 116763(1), Tortugas; 34447(1), unknown locality; 27561(1), dried specimen from St. Thomas, Virgin Islands. From CNHM: 48720(1), Bermuda.

Antennarius oligospilos Bleeker

PLATE 11,B

Antennarius oligospilos Bleeker, Acta Soc. Sci. Indo-Neerlandicae, vol. 2, p. 70, 1857 (type locality, Amboina); Atlas ichthyologique, vol. 5, p. 11, pl. 195, fig. 1, and pl. 200, fig. 1, 1865 (Amboina; Ceram; New Guinea).—Smith, The sea fishes of southern Africa, p. 431, pl. 98, fig. 1241, 1949 (Durban; Delagoa Bay).

This species was distinguished by Bleeker on the basis of "warts" on the skin. *A. oligospilos* is similar to *A. commersoni* except for the warts, and the last pelvic ray is unbranched. It resembles *A. phymatodes* Bleeker in regard to warts on the skin but that species does not have any branched rays except those of the caudal fin. I have not seen a specimen.

Antennarius sanguineus Gill

PLATE 10,D

Antennarius sanguineus Gill, Proc. Acad. Nat. Sci. Philadelphia, p. 91, 1863 (type locality, Cape San Lucas; 2 types, USNM 6393).

Antennarius leopardinus Günther, Proc. Zool. Soc. London, p. 151, 1864 (type locality Pacific Coast, Panamá); Trans. Zool. Soc. London, vol. 6, pt. 7, pl. 69, fig. 3, 1869 (Panamá).

Antennarius tagus Heller and Snodgrass, Proc. Washington Acad. Sci., vol. 5, p. 226, p. 20, 1903 (type locality, Tagus Cove, Albemarle Island, Galápagos).

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First dorsal spine about same length as the second, which has a "hooked tip," third dorsal spine bound down by skin and not movable in adults but somewhat movable in the young; naked area behind second dorsal spine; only last two or three soft rays of dorsal branched or divided, only last ray of pelvic divided; caudal peduncle scarcely or not distinct; none of pectoral rays branched; anal rays all divided; background coloration light tan or light brown, overlaid with dark brown spots, more numerous and larger ventrally, especially larger on belly; a small ocellate spot basally on soft dorsal; fins with small brown spots.

I have studied five specimens of *A. sanguineus* in addition to the types. From USNM: 18604(1), Cape San Lucas; 101755(1), Gorgona Island, Colombia. From CNHM: 41442(1), Albemarle Island, Galápagos; 60276(1), Gulf of Nicoya, Costa Rica; 60278(1), Acapulco, México.

Antennarius drombus Jordan and Evermann

Plate 11,c,d.

Antennarius drombus Jordan and Evermann, Bull. U. S. Fish Comm., vol. 22, p. 207, 1903 (type locality, Waikiki, near Honolulu; holotype, USNM 50659); Ibid., vol. 23, p. 521, pl. 64, 1905 (Waikiki).

Antennarius nexilis Snyder, Bull. U. S. Fish Comm., vol. 22, p. 537, pl. 13, fig. 23, 1904 (type locality, Honolulu; holotype, USNM 50883).—Jordan and Evermann, Bull. U. S. Fish Comm., vol. 23, pt. 1, p. 523, pl. 65, fig. 1, 1905 (Honolulu).

First dorsal spine about same length as second; latter without a definite naked area behind its base, although sometimes it is partly naked; third dorsal spine bound down with skin, scarcely movable; last two or three soft dorsal and last pelvic ray divided; none of pectoral rays divided; anal rays all divided; caudal peduncle scarcely present; color dark brown with darker brown or blackish spots on body and fins; no ocellate spot on soft dorsal.

In addition to the two holotypes, I have studied 12 specimens. From USNM: 119772(1), from Cocos Island, Eastern Pacific; 160709(2), Hawaii; 167510(1), Oahu. Dr. John Randall sent me a Kodachrome transparency taken of a Oahu specimen. The fish was profusely blackspotted after preservation. When alive it had "many conspicuous pink areas" and the blackish spots were not distinct. Dr. Robert R. Harry loaned to me 8 specimens collected by him from the reefs on the northwest side of Laysan Island, June 27–July 3, 1951, while he was with the George Vanderbilt Pacific Equatorial Expedition.

Antennarius coccineus (Lesson)

Plate 12,a

Chironectes coccineus Lesson, Voyage autour du monde, *La Coquille*, Zool., vol. 2, pt. 1, p. 143, pl. 16, fig. 1, 1830 (type locality, Mauritius) [Dr. de Beaufort examined the type of this species and in a letter stated "the dorsal and anal end close to base of caudal;" therefore, Lesson's figure 1 is inaccurate].—Cuvier and Valenciennes, Histoire naturelle de poissons, vol. 12, p. 430, 1837 (on Lesson).

Antennarius coccineus Bleeker, Atlas ichthyologique, vol. 5, p. 22, pl. 197, fig. 2, 1865 (Java; Cocos; Nias; Singapura; Sangi; Buro; Amboina; Ceram; Goram).—Smith, The sea fishes of southern Africa, p. 431, pl. 98, fig. 1238, 1949 (Natal).

Antennarius stigmaticus Ogilby. Mem. Queensland Mus., vol. 1, p. 63, pl. 14, fig. 2, 1912 (type locality, Moreton Bay, Queensland).

Antennarius leucas Fowler, Proc. Acad. Nat. Sci. Philadelphia, vol. 86, p. 512, fig. 53, 1934 (type locality, Durban, Natal, holotype ANSP 54955, examined by me).

Antennarius punctatissimus Fowler, Proc. Acad. Nat. Sci. Philadelphia, vol. 98, p. 216, fig. 76, 1946 (type locality, Aguni Shima, Riu Kiu Islands, holotype ANSP 72089, examined by me).

This species has first dorsal spine short, about same length as second, with naked area behind second dorsal spine; third dorsal spine partly bound down with skin and only partly movable; only the last two or three soft dorsal rays and last pelvic rays divided; pectoral rays all simple, undivided; anal rays all divided; caudal peduncle absent or nearly so; background color light tan, somewhat marbled or profusely peppered with dark dots; occasionally a trace of a dark spot near midbase of soft dorsal on young and those as large as 32 mm. in standard length.

I have studied 24 specimens. From USNM: 113988(1), 113989(1), 113986(1), 113987(3), 113990(1), all from Bikini Atoll; 167506(1), Onotoa Atoll; 164193(1), Arnol Atoll; 52280(1), Samoan Islands; 133868(1), Tonga Island, Paumotu. From University of Washington: 1 from Bikini Atoll. From Chicago Natural History Museum: 1 from the Marshall Islands. From Dr. Robert R. Harry: 6 from Ifaluk Atoll; 4 from Kapingamarangi Atoll. From Dr. John Randall: 1 from Moorea, Society Islands.

Antennarius dorehensis Bleeker

Plate 12,b

Antennarius dorehensis Bleeker, Acta Soc. Sci. Indo-Neerlandicae, vol. 6, p. 21, 1859 (type locality, New Guinea); Atlas ichthyologique, vol. 5, p. 19, pl. 199, fig. 7, 1865 (Doreh, New Guinea).

This species with the first dorsal spine about same length as second, bait a tuft of filaments, has about the last four soft dorsal rays divided;

none of pelvic or pectoral rays divided; anal rays all divided; caudal peduncle distinct. Background coloration blackish, everywhere speckled with white dots. This species is known from Bleeker's description and figure. I have not seen a specimen nor have I seen the specimens reported upon as this species by Herre (Copeia, No. 3, p. 149, 1945) from Estancia, Panay.

Antennarius bermudensis, new species

Plate 12,c

Holotype: USNM 50000, Hungry Bay, Bermuda (Paget County), F. Goodwin Gosling, standard length 51 mm., total length 65 mm.

Paratype: CNHM 48862, Harrington Sound, Bermuda, April 1931, L. L. Mobray, standard length 61.5 mm., total length about 79 mm.

Description: The following counts were made on the holotype and paratype respectively: Dorsal I–I–I,12 and I–I–I,12; anal 7 and 7; pectoral 9–9 and 10–10; pelvics 5 and 5; caudal 4+5 and 4+5.

The following characters are recorded in thousandths of the standard length, for the holotype and paratype, respectively. Standard length 51 and 61.5 mm. Greatest depth of body 686 and 650; length of bony part of first dorsal spine 118 and 114; of second dorsal spine 127 and 114; of third dorsal spine 225 and 195; longest soft dorsal ray 223 and 276; longest (middle) caudal ray 275 and 276; length of head (tip of snout to gill opening) 628 and 634; length of maxillaries 260 and 293; least depth of caudal peduncle 123 and 130; length of caudal peduncle (distance between vertical lines through caudal fin base and rear of membranous bases of anal and dorsal fins) 27 and 29; length of base of soft dorsal fin 461 and 495; eye diameter 59 and 55; interorbital space 184 and 163.

The bony part of first dorsal spine about same length as second dorsal spine, bearing filaments at its tip; second dorsal spine curved, covered with denticles and with tentacles; third dorsal spine bound down with skin except its tip, scarcely movable; area behind base of second dorsal spine naked; all soft dorsal rays simple except last two may or may not be divided; anal and caudal rays all divided, pectoral rays all simple; only last pelvic ray branched; caudal peduncle almost absent; body and head profusely covered with denticles.

Color in Alcohol: Background color brownish above, very light tan on belly; everywhere speckled with darker brown; median fins somewhat barred; a large ocellate spot basally on soft dorsal rays 8 to 11 more on body than on base of fin; lateral line with dark brown spots; pectoral and pelvic fins with dark spots.

Remarks: This new species may be distinguished by the key from all others referred to the genus *Antennarius*. It is most closely related

to *drombus* and *coccineus* of the Pacific, differing in having one more soft dorsal ray and an ocellate spot on the soft dorsal, absent in the two species from the Pacific.

Named in reference to the island group where the type was collected.

Antennarius notophthalmus Bleeker

PLATE 13,A,B

Antennarius notophthalmus Bleeker, Nat. Tijdschr. Nederlandsch-Indië, vol. 5, p. 544, 1853 (type locality, Java); Atlas ichthyologique, vol. 1, p. 16, pt. 196, fig. 1, 1865 (Java; Nias; Celebes; Batjan; Amboina; Ceram).

Antennarius biocellatus (non Cuvier 1817) Bleeker, Acta Soc. Sci. Indo-Neerlandicae, vol. 8, p. 4, 1860 (type locality, Amboina); Atlas ichthyologique, vol. 5, p. 18, pl. 194, fig. 3, pl. 198, fig. 5, 1865 (Amboina).—Smith, The sea fishes of southern Africa, p. 431, pl. 98, fig. 1237, 1949 (East London to Delagoa Bay).

This species with first dorsal spine about as long as second has the bait composed of a tuft of filaments; none of pelvic or pectoral rays divided; last two or three soft dorsal rays divided; anal rays all divided; caudal peduncle distinct; background coloration brownish, sometimes overlaid with a coarse network of darker brown marks; or mottled and spotted with brown; usually a dark bar or saddle between third dorsal spine and soft dorsal origin, usually an ocellate spot posterobasally on soft dorsal fin.

I have studied two specimens. From USNM: 133169(1) and 150949(1) from the Philippines.

Antennarius verrucosus Bean

PLATE 12,D

Antennarius verrucosus Bean, Proc. Biol. Soc. Washington, vol. 19, p. 31, 1906 (type locality, St. George Island, Bermuda).

This species, with first dorsal spine about same length as second, has the bait consisting of a tuft of filaments; third dorsal spine movable; naked area behind base of second dorsal spine; caudal peduncle distinct; last two or three soft dorsal rays divided; last pelvic ray divided; anal rays all divided; none of pectoral rays divided; background color light tan, overlaid with brown streaks and bars, those dorsally with pale centers; fins brown-spotted, those on dorsal and caudal fins with pale centers.

I have studied two specimens. From USNM: 164244(1), Bermuda. From CNHM: 46818(1), Florida.

Antennarius altipinnis Smith and Radcliffe

PLATE 13,C

Antennarius altipinnis Smith and Radcliffe, *in* Radcliffe, Proc. U. S. Nat. Mus., vol. 42, p. 204, fig. 3, 1912 (type locality, Nogas Point, Panay, Philippines; holotype, USNM 70267).

Antennarius albomarginatus Fowler, Proc. Acad. Nat. Sci. Philadelphia, vol. 97, p. 74, fig. 19, 1945 (type locality, Saipan Island; type, Academy of Natural Sciences of Philadelphia (ANSP) No. 71609, examined by me).

Antennarius niveus Fowler, Proc. Acad. Nat. Sci. Philadelphia, vol. 98, p. 215, fig. 75, 1946 (type locality, Aguni Shima, Riu Kiu Islands; type, ANSP 72088, examined by me).

This rather common species in the Philippines has the first dorsal spine shorter than the second dorsal spine, and the bait consists of a tuft of filaments; no naked area behind second dorsal spine; last two or three soft dorsal rays divided, as is the last pelvic ray; anal rays all divided; all of pectoral rays undivided; third dorsal spine somewhat bound down by skin but movable; caudal peduncle distinct but short; background coloration brownish and somewhat dark-spotted; cirri on body usually whitish; median fins notably dark brown except distally with broad white or pale edges; pale bar across caudal fin basally is a characteristic mark.

In addition to the types, I have studied 16 specimens. From USNM: 122342(1), 122811(2), 122343(1), 122344(1), 122808(2), 122809(1), 150939(1), 150950(1), 150995(1), all from the Philippines; 154625(1), Guam; 164196(1), Palau Islands. From Australian Museum, Sydney, 1 from Gilbert Islands. From ANSP: 71818(1), Fiji. From Dr. R. R. Harry: 2, collected by him at Kapingamarangi Atoll in 1954.

***Antennarius pauciradiatus*, new species**

Figure 7

Antennarius pleurophthalmus (non Gill) Longley and Hildebrand, Papers Tortugas Lab., vol. 34, p. 308, 1941 (Tortugas, Fla., only the 40 and 42 mm. specimens).

Holotype: USNM 153226, off Palm Beach, Fla., in 30 to 40 fathoms on rocky reef, August 1950, collected by Thompson and McGinty, standard length 20 mm. and total length 28 mm.

Paratypes: USNM 82583, off Cape San Antonio, Cuba, May 24, 1914, Bartsch and Henderson, 1 specimen, 16.5 mm.; USNM 153146, off Palm Beach, Fla., 1950, McGinty, 2 specimens, 13.8 and 15.5 mm.; USNM 153147, off Palm Beach, Fla., 20 to 30 fathoms, April 1950, Thompson and McGinty, 2 specimens, 12.5 and 15.5 mm.; USNM 153148, off Palm Beach in 20 fathoms, March 1950, McGinty, 1 specimen, 12 mm.; USNM 153223, off Palm Beach, Fla., sand and rocky reef, Aug. 2, 1950, Thompson and McGinty, 2 specimens, 21 and 26.5 mm.; CNHM 50249, South end of Biscayne Bay, Fla., W. B. Grey, July–August 1949, 2 specimens, 35 and 40 mm. (in poor condition); USNM 116764, Tortugas, Fla., W. H. Longley, 2 specimens, 30 and 31 mm. (40 and 42 mm. total length).

Description: The following counts were made on the holotype (additional counts are recorded in table 1): Dorsal rays I–I–I–12; anal 7; pectoral 9–10.

The following characters are recorded in thousandths of the standard length for the holotype and one paratype, respectively: Standard length 20 and 30 mm. Greatest depth of body 600 and 550; length of bony part of first dorsal spine 55 and 50; of second dorsal spine 110 and 97; of third dorsal spine 325 and 297; longest soft dorsal ray 270 and 300; longest (middle) caudal ray 425 and 417; length of head (tip of snout to gill opening) 600 and 600; length of maxillaries 215 and 220; least depth of caudal peduncle 150 and 147; length of caudal peduncle (distance between vertical lines thru caudal fin base and rear of membranous bases of anal and dorsal fins) 90 and 100; length of base of soft dorsal fin 550 and 584; eye diameter 95 and 67; interorbital space 110 and 93.

The bony part of first dorsal spine much shorter than second dorsal spine, bearing at its tip a tuft of filaments; second dorsal spine curved and short; third dorsal spine notably much longer than second; both second and third spines with membranes behind; the third spine becoming partly bound down to body on the largest specimens (26.5 and 40 mm.) but still somewhat movable; only last two or three soft dorsal rays divided; only last pelvic ray divided; caudal rays all

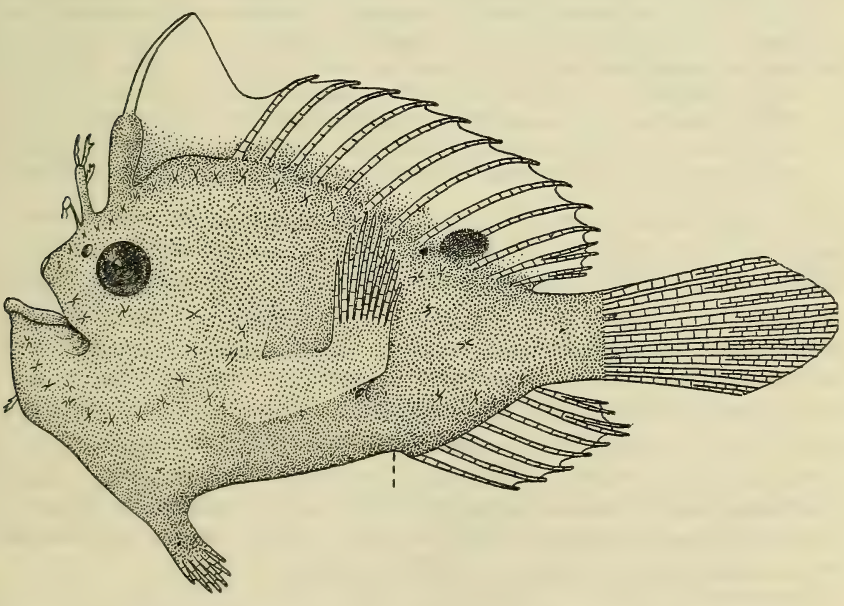

Figure 7.—*Antennarius pauciradiatus*, new species. Drawing by Mrs. A. M. Awl of holotype, USNM 153226, from Florida.

branched; anal rays all branched; pectoral rays all simple; gill opening close to base of pectoral fin; caudal peduncle distinct; skin with fine denticles almost everywhere on body and head; scattered dermal cirri present.

Color in alcohol: Background coloration almost whitish, somewhat tinged with pink, larger specimens light tan; a few dark dots present on a few specimens mostly on head and fins; the most characteristic mark is a small ocellate spot basally on soft dorsal fin between rays 8 to 10.

Remarks: This new species has been confused with *A. radiosus*, *A. multiocellatus*, and *A. ocellatus*, all of the Western Atlantic. The reason for this confusion is the presence of an ocellate spot in the soft dorsal fin of these four species. *A. radiosus* has 13 or 14 pectoral rays and *A. ocellatus* has 11 to 13, whereas the new species has only 8 to 10, usually 9. *A. multiocellatus* differs from *A. pauciradiatus* in having 10 pectoral rays instead of 9, rarely 10, and in addition the first dorsal spine of *multiocellatus* is much longer than the second.

This new species is named in reference to the fewer pectoral rays as compared with closely related species in the Western Atlantic.

Antennarius nummifer (Cuvier)

Figure 8

Chironectes nummifer Cuvier, Mém. Mus. Hist. Nat. Paris, vol. 3, p. 430, pl. 17, fig. 4, 1817 (no locality given); Cuvier and Valenciennes, Histoire naturelle des poissons, vol. 12, p. 425, 1837 (coast of Malabar).

Antennarius sanguifluus Jordan, *in* Jordan and Sindo, Proc. U. S. Nat. Mus., vol. 24, p. 374, fig. 5,[1] 1902 (type locality, Misaki, Japan; holotype, USNM 49820)—Jordan, Tanaka and Snyder, Journ. Coll. Sci. Tokyo Imp. Univ., vol. 23, art. 1, p. 424, fig. 393, 1913 (Japan).—Okada and Matsubara, Keys to the fishes and fishlike animals of Japan, p. 457, pl. 112, fig. 2, 1938 (Japan).

The first dorsal spine, about the same length as second, has the bait consisting of a tuft of filaments; area behind second dorsal spine naked; third dorsal spine movable, tip hooked or nearly so; last 2 or 3 soft dorsal rays and last pelvic ray divided; all pectoral rays simple; anal rays all divided; caudal peduncle distinct; background coloration light tan or brownish, somewhat mottled with darker brown; large ocellate spot posterobasally on soft dorsal fin between rays 7 and 9; tentatively, I refer CNHM 51864 to this species as it agrees in every respect except its generally blackish color. Since other species of *Antennarius* apparently have a black color phase, I presume it could happen in this one too. Series of antennariids are not available for the study of such problems.

[1] Drawing in error; last pelvic ray is divided in the holotype.

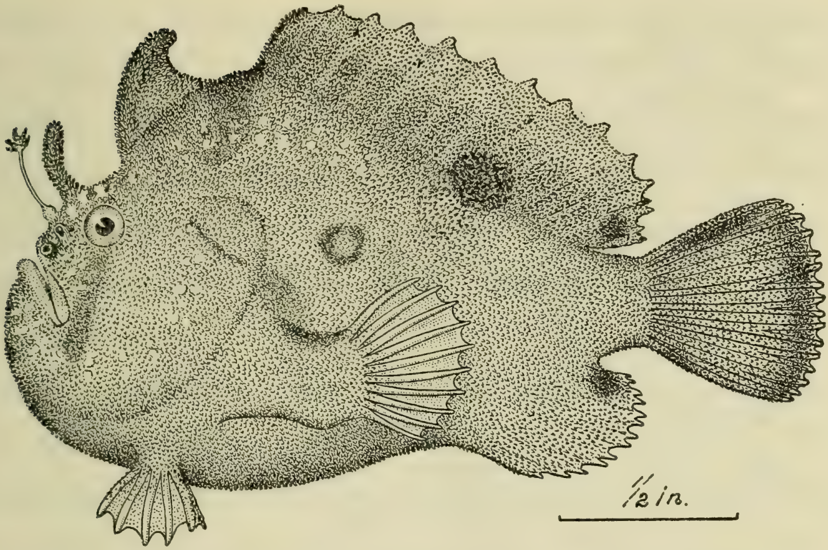

FIGURE 8.—*Antennarius nummifer* (Cuvier). Drawing of type of *A. sanguifluus* retouched by author.

In addition to the holotype of *A. sanguifluus*, I have studied 21 specimens. From USNM: 167505(1), Onotoa Atoll, Gilbert Islands, collected by Dr. John Randall. From CNHM: 2487(6) and 5752(3) both from Persian Gulf; 51864(1), Sandakan District, Northern Borneo. Dr. R. A. Harry loaned 10 specimens from the Caroline Islands.

Subfamily Histrioninae

Genus *Histrio* Fischer

Histrio Fischer, Zoognosia, ed. 3, vol. 1, pp. 70, 78, 1813 (genotype, *Lophius histrio* Linnaeus).

Pterophryne (non *Pterophrynus* Lütken 1863) Gill, Proc. Acad. Nat. Sci. Philadelphia (1863), p. 90, 1864 (genotype, *Chironectes laevigatus* Cuvier).

Pterophrynoides Gill, Proc. U. S. Nat. Mus., vol. 1, p. 216, 1878 (genotype, *Lophius histrio* Linnaeus; proposed to replace *Pterophryne* Gill).

Histrio histrio (Linnaeus)

PLATE 13,D

Lophius histrio Linnaeus, Systema naturae, ed. 10, p. 237, 1758 (type locality, pelagic in *Fucus*).—Shaw, General zoology, vol. 5, pt. 2, p. 384, pl. 164, 1804 (Indian and American Seas).—Smith, Sea fishes of southern Africa, p. 431, pl. 98, fig. 1243, 1949 (pelagic).

?*Lophius marmoratus* Shaw and Nodder, Naturalist's miscellany, vol. 5, pl. 176, 1794 (no locality).

?*Lophius pictus* Shaw and Nodder, Naturalist's miscellany, vol. 5, pl. 176, 1794 (no locality).

Lophius raninus Tilesius, Mém. Soc. Nat. Moscou, vol. 2, p. 245, pls. 16, 17, 1809 (no locality).

Lophius cocinsinensis Shaw and Nodder, Naturalist's miscellany, vol. 23, pl. 1012, p. ?, 1812 (type locality, Indian Seas).

Lophius gibbus Mitchill, Trans. Lit. Philosoph. Soc. New York, vol. 1, pl. 4, fig. 9, 1815 (no locality given).

Chironectes laevigatus Cuvier, Mém. Mus. Hist. Nat. Paris, vol. 3, p. 423, pl. 16, upper fig., 1817 (type locality, Atlantic Ocean).

Lophius histrio marmoratus Bloch and Schneider, Systema ichthylogiae, p. 142, 1801 (no locality given).

Lophius geographicus Quoy and Gaimard, Voy. *Uranie . . . Physicienne*, Zool., p. 355, pl. 65, fig. 3, 1824 (type locality, New Guinea).

Lophius histrio pictus Bloch and Schneider, Systema ichthyologiae, p. 142, 1801 (no locality).

Chironectes pictus Cuvier and Valenciennes, Histoire naturelle des poissons, vol. 12, p. 393, pl. 363, 1837 (middle of Atlantic).

Chironectes tumidus Cuvier and Valenciennes, Histoire naturelle des poissons, vol. 12, p. 397, 1837 (type locality, Atlantic).

Chironectes arcticus Düben and Koren, Kongl. Vet. Akad. Handl., p. 72, pl. 3, figs. 4, 5, 1844 (type locality, Atlantic).

Chironectes pictus var *vittatus* Richardson, Voy. *Erebus* and *Terrior*, Fishes, p. 15, pl. 9, figs. 3, 4, 1844 (type locality, tropical Atlantic).

Chironectes sonntagii Müller, Reisen in den Vereinigten Staaten, Canada und Mexico, vol. 1, pt. 2, p. 180, 1864 (type locality, Gulf Stream).

Antennarius inops Poey, Anal. Soc. Española Hist. Nat., vol. 10, p. 340, 1881 (type locality of holotype, USNM 37434, Puerto Rico).

Histrio jagua Nichols, Proc. Biol. Soc. Washington, vol. 33, p. 62, 1920 (type locality, Bermuda.)

Histrio gibba, Longley and Hildebrand, Papers Tortugas Lab., vol. 34, p. 303, pl. 34, 1941 (Panamá; West Indies; Florida).

Pterophrynoides histrio Whitley, Rec. Australian Mus. vol. 17, p. 137, pl. 31, fig. 4, 1929 (New South Wales).—Koefoed, Rep. Sci. Results *Michael Sars* North Atlantic Deep-Sea Exped., 1910, vol. 4, pt. 2, No. 1, p. 3, pl. 3, figs. 1, 2, 1944 (North Atlantic).

I have compared specimens from the Atlantic, East and West Pacific, and Indian Oceans and did not find any significant differences throughout the entire range in tropical marine waters. I conclude that only one species is represented.

The largest Atlantic specimen observed by me measures 106 mm. in standard length and a total length of 140 mm. In the Pacific, one from the Philippines is 140 mm. standard length and 195 mm. in total length.

I have studied 452 specimens, as follows:

ATLANTIC OCEAN

Western Atlantic Ocean: USNM 4880(1), 21250(1), 38043(1), 39474(6), 44245(1), 82620(2), 83863(33), 92639(1), 92689(1), 92691(2), 92749(1); CNHM 34216(1), 34219(1), 34220(1).

Gulf of Maine: USNM 164190(8), 164191(4).

Massachusetts: USNM 20661(1), 125415(5).

Delaware: USNM 87584(1).

North Carolina: USNM 53257(6), 73535(1).

South Carolina: USNM 131631(1).

Florida: USNM 18045(1), 49587(1), 49704(1), 88097(1), 89368(2), 89712(1), 89713(1), 89788(1), 92219(1), 116765(9), 116766(1), 119123(1), 126789(1), 134017(4), 134323(1), 135674(4), 155494(1), 163948(1), 164183(1), 164185 to 164189(5); CNHM 16156(1), 21703(1), 46140(1), 46895(1), 50219(1), 50250(1), 50261(4).

Carribbean, Bahamas, West Indies, Curaçao: USNM 20420(6), 37544(1), 53259(3), 38766(1), 53258(1), 53260(7), 53261(1), 108326(1), 108327(1), 108370(1), 128801(1), 132620(1), 133908(1), 164177(2), 164184(20); CNHM 50259(1), 60277(1).

Gulf of Mexico: USNM 37239(1), 73588(1), 84579(1), 84580(1), 120233(1), 131525(1), 133880(1), 164178(1), 164180(2), 164181(3), 164182(1); CNHM 35361 to 35365(5).

Panamá (Atlantic): USNM 81781(1), 81788(1).

Bermuda: USNM 105268(3); CNHM 5290 to 5293(4), 8550(1), 48213(1), 48252(1), 48358(1), 48516(1), 48545(1), 48581(1), 48601(1), 48805(1), 48894(26), 49176(1), 49177(1), 49178(1).

Trinidad: USNM 164179(1).

PACIFIC OCEAN

Galápagos Islands: USNM 20403(2), 84612(6), 92698(1).

Hawaiian Islands: USNM 82842(2).

Japan: USNM 76259(2); CNHM 55403(1).

China: USNM 56401(5).

Philippine Islands: USNM 56315(1), 122385(16), 122543(1), 122817(170), 122818(2).

Australia (Newcastle): USNM 150941(1).

New Scientific Names

Following is a list of new scientific names appearing in this paper.

Kanazawaichthys, new genus (p. 62)

Kanazawaichthys scutatus, new species (p. 63)

Nudiantennarius, new genus (p. 66)

Abantennarius, new genus (p. 66)

Abantennarius analis Gosline, new species (p. 67)

Triantennatus, new subgenus (p. 74)

Phrynelox zebrinus, new species (p. 75)

Phrynelox atra, new species (p. 76)

Antennatus, new genus, new subgenus (p. 80)

Xenophrynichthys, new subgenus (p. 81)

Uniantennatus, new subgenus (p. 83)

Plumantennatus, new subgenus (p. 89)

Antennarius bermudensis, new species (p. 98)

Antennarius pauciradiatus, new species (p. 100)

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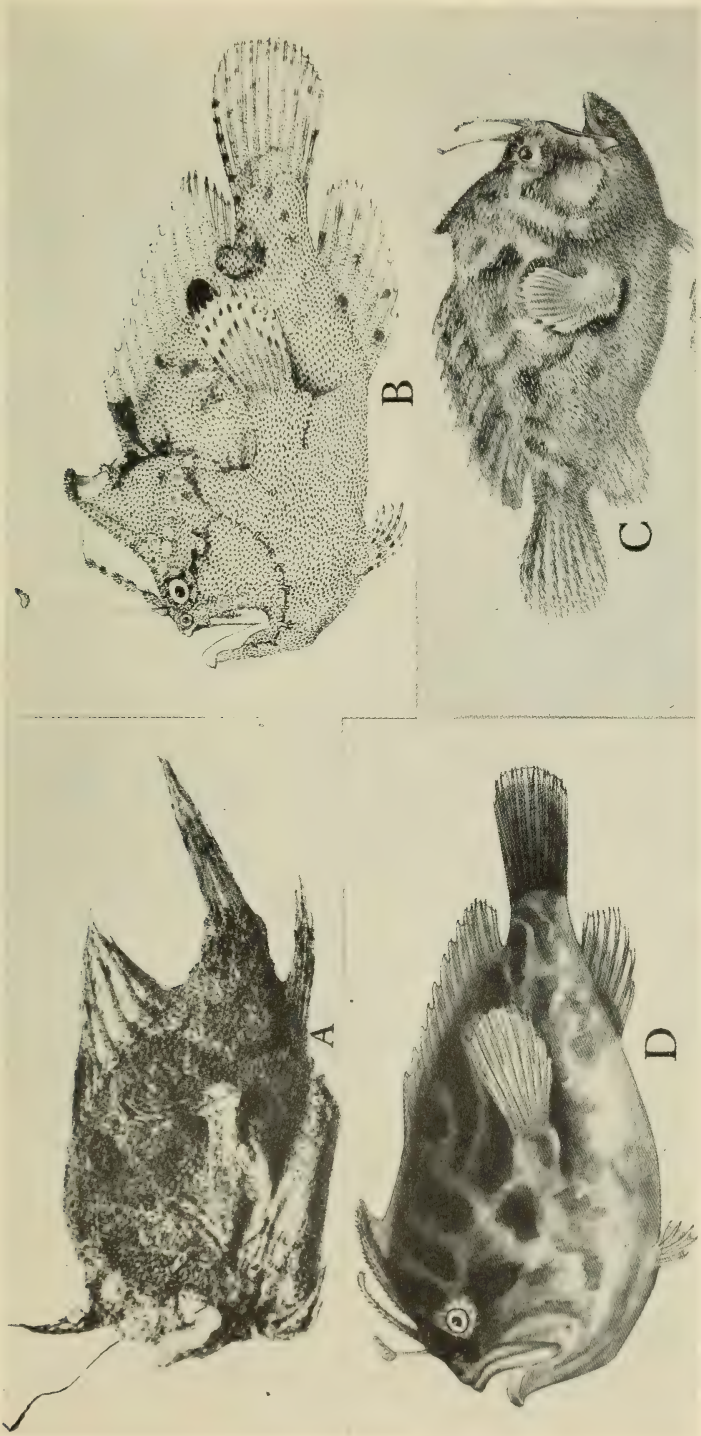

A, *Tathicarpus butleri* Ogilby, after holotype of *T. appeli* Ogilby. B, *Trichophryne rosaceus* (Smith and Radcliffe), holotype, USNM 70266. C, *Trichophryne mitchelli* (Morton) after McCulloch and Waite 1918. D, *Nudiantennarius subteres* (Smith and Radcliffe) after holotype, USNM 70268.

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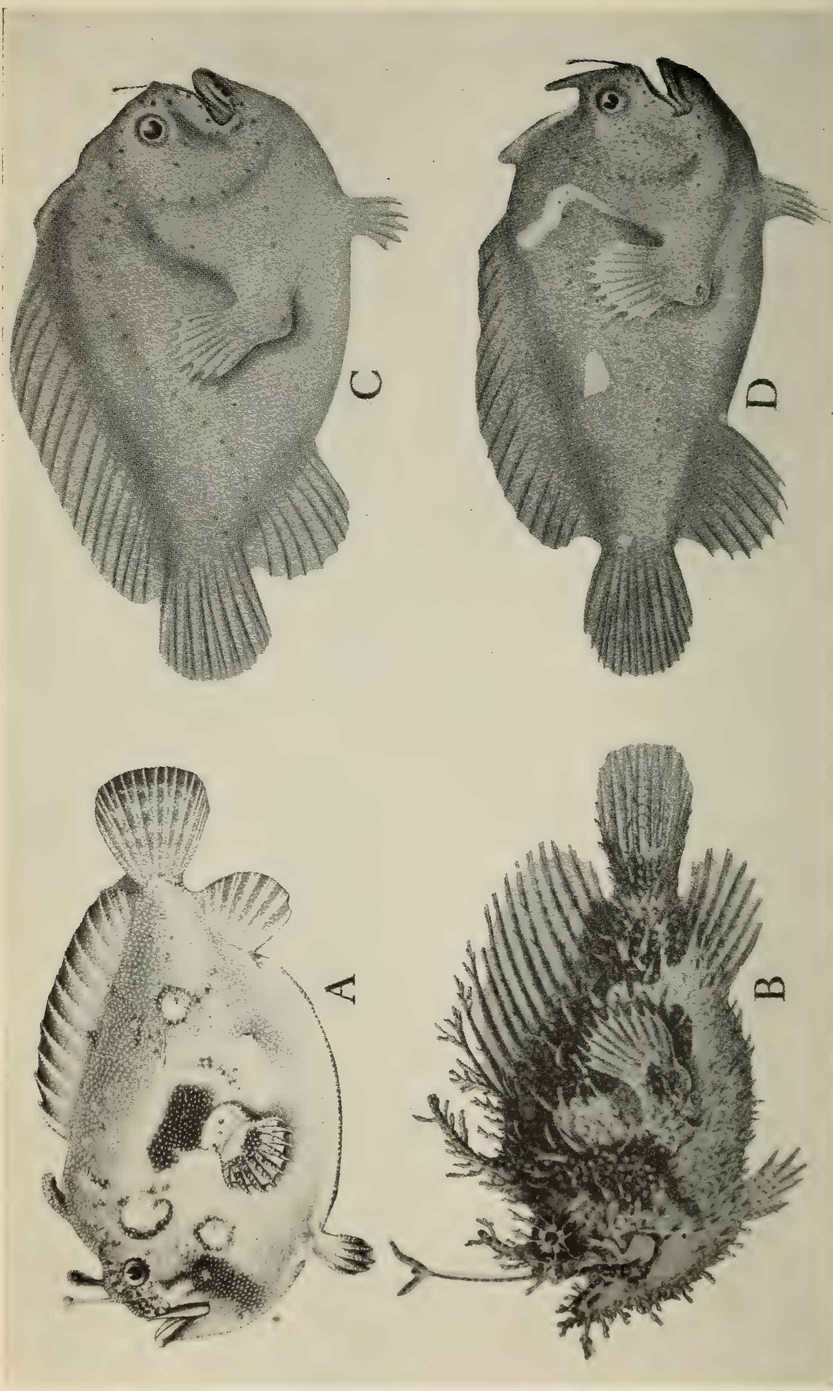
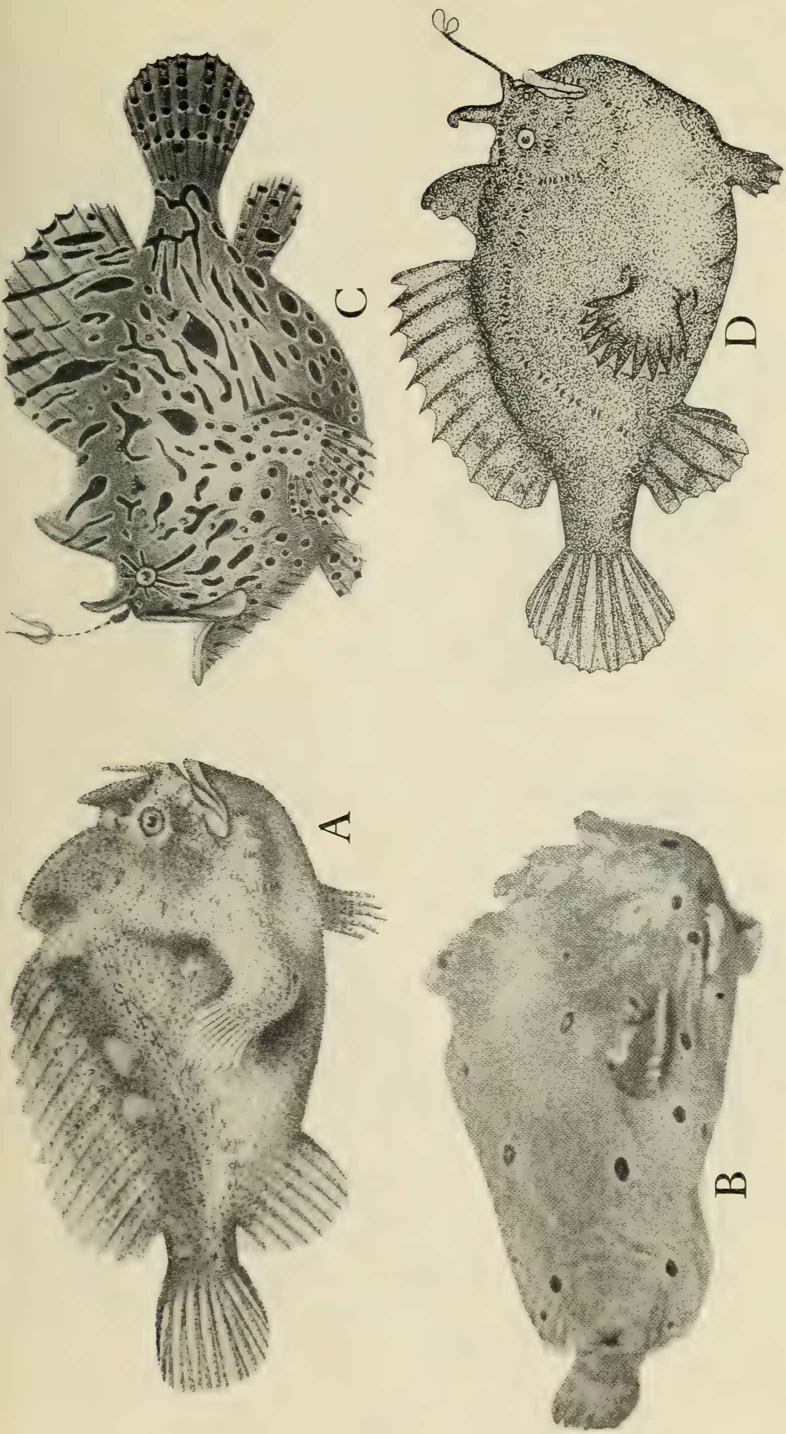
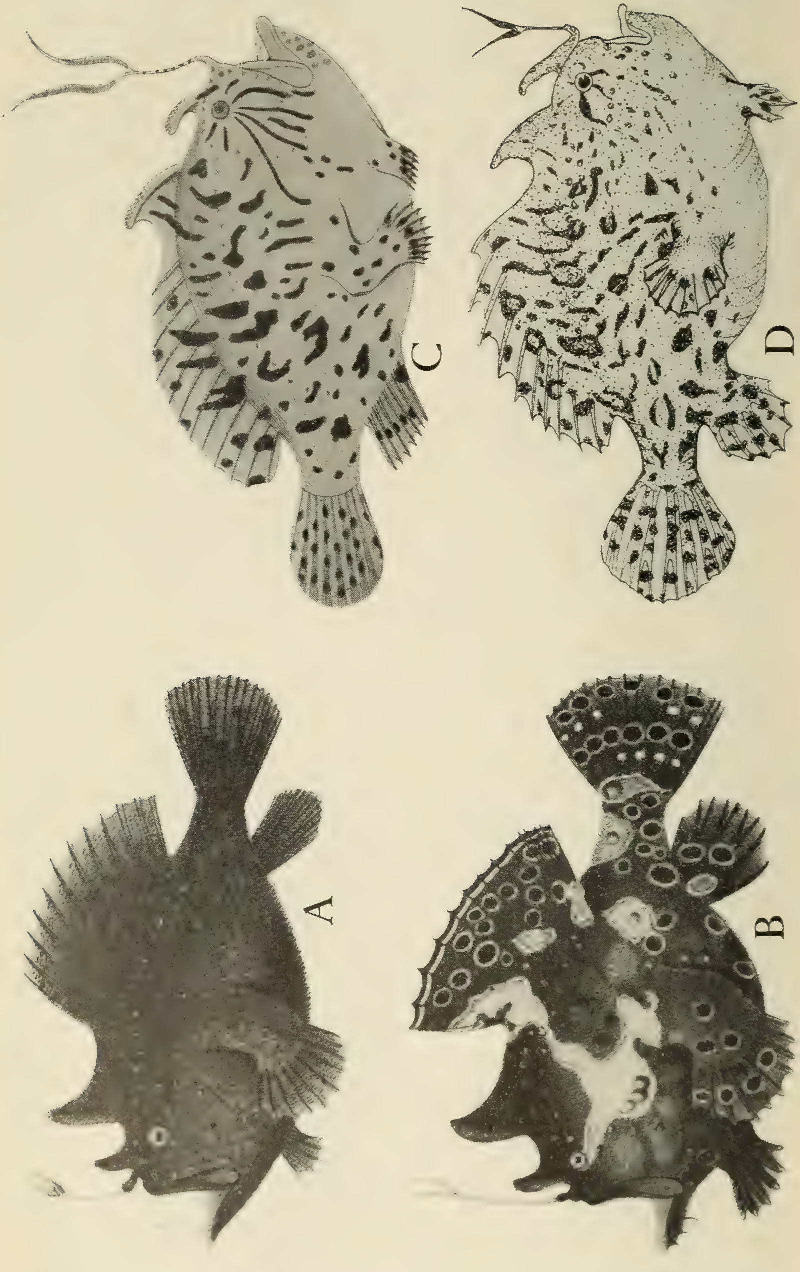


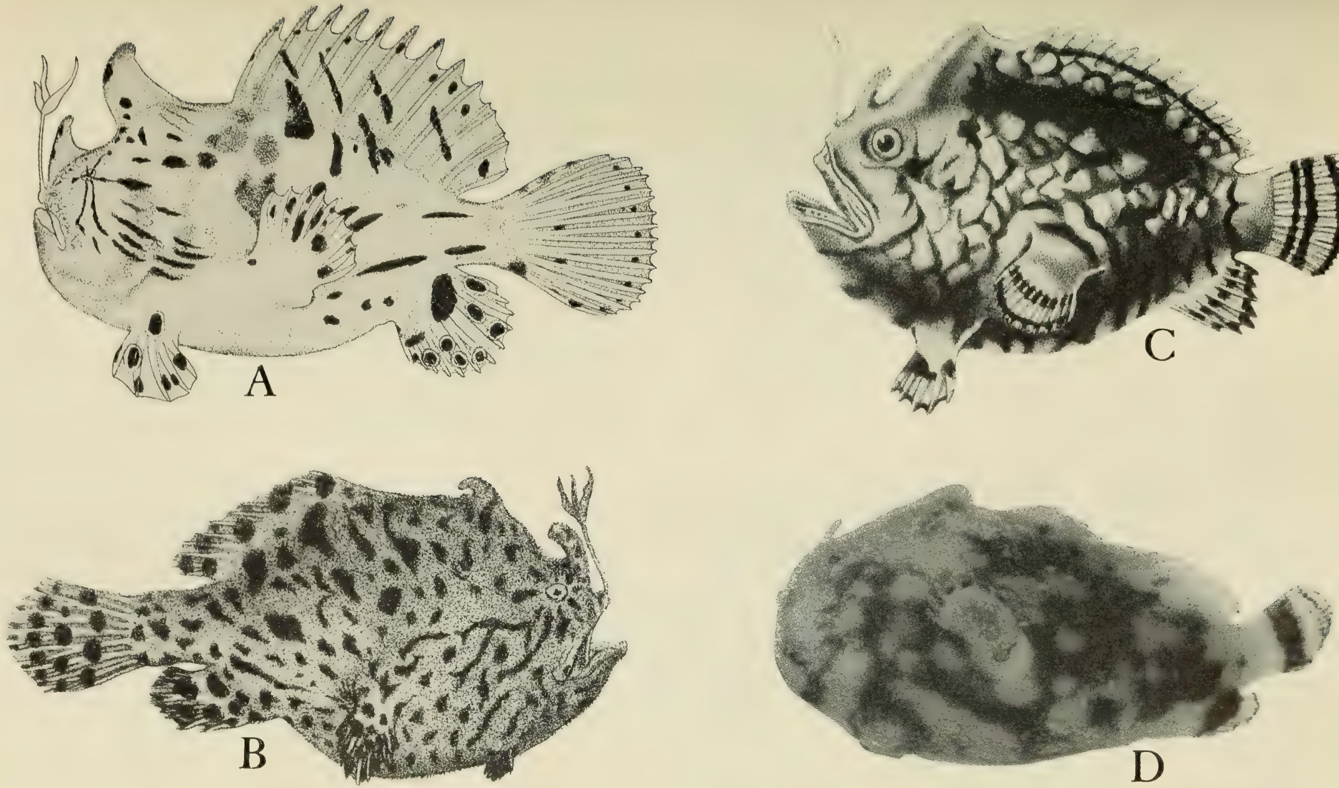
A, *Abantennarius duescus* (Snyder), after Snyder, holotype, USNM 50884. B, *Rhycherus filamentosus* (Castelnau), after McCulloch and Waite 1918. C, *Histiophryne bougainvilli* (Cuvier and Valenciennes), after McCulloch and Waite 1918. D, *H. scortea* McCulloch and Waite, after figure by authors.



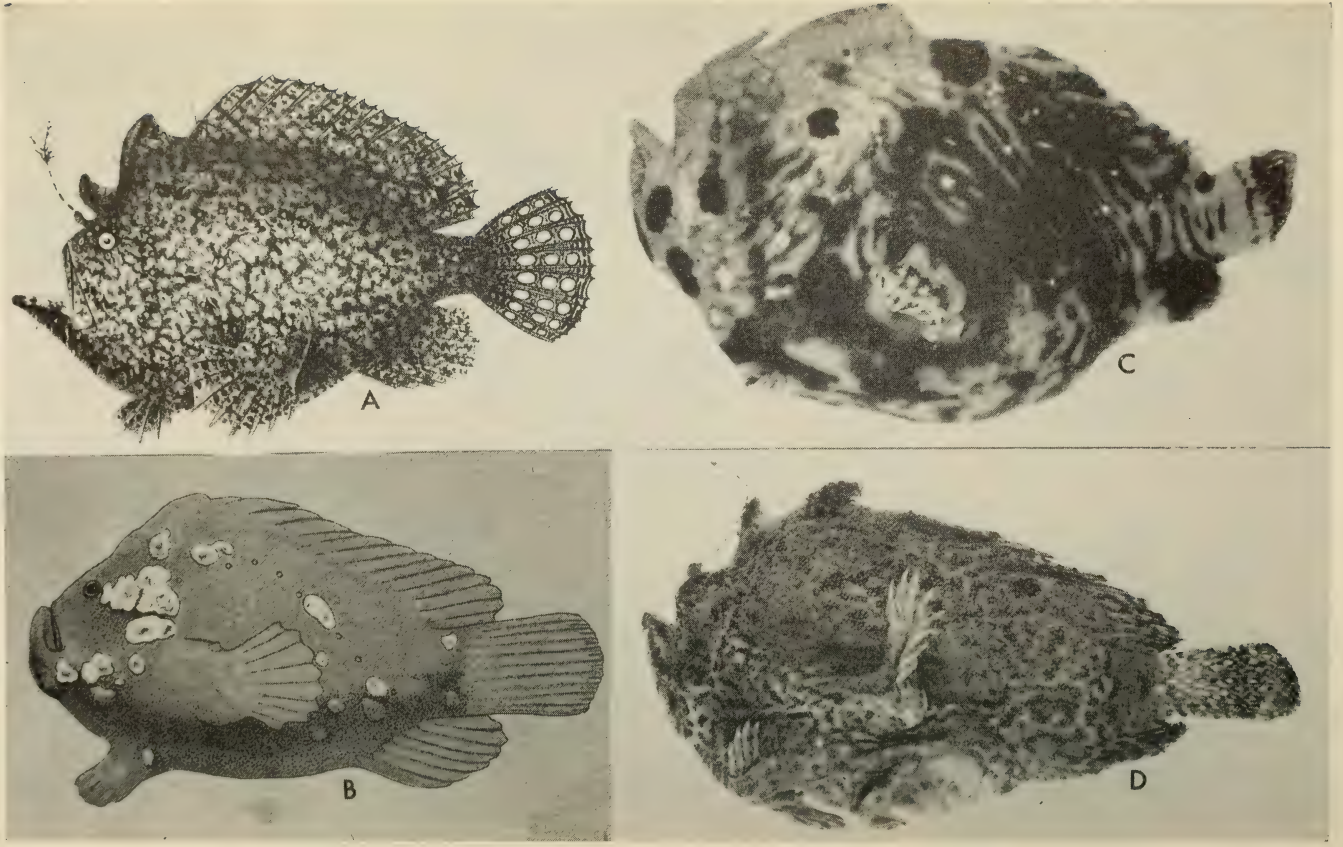
A, *Echinophryne crassispina* McCulloch and Waite, after holotype by authors. B, *E. glauerti* Whitley, after Whitley 1944. C, *Phrynelox striatus* (Shaw), after Bleeker (Atlas, vol. 5, pl. 197, fig. 5, on *A. pinnaceps*). D, *Phrynelox nuttingi* (Garman), after Barbour 1942.



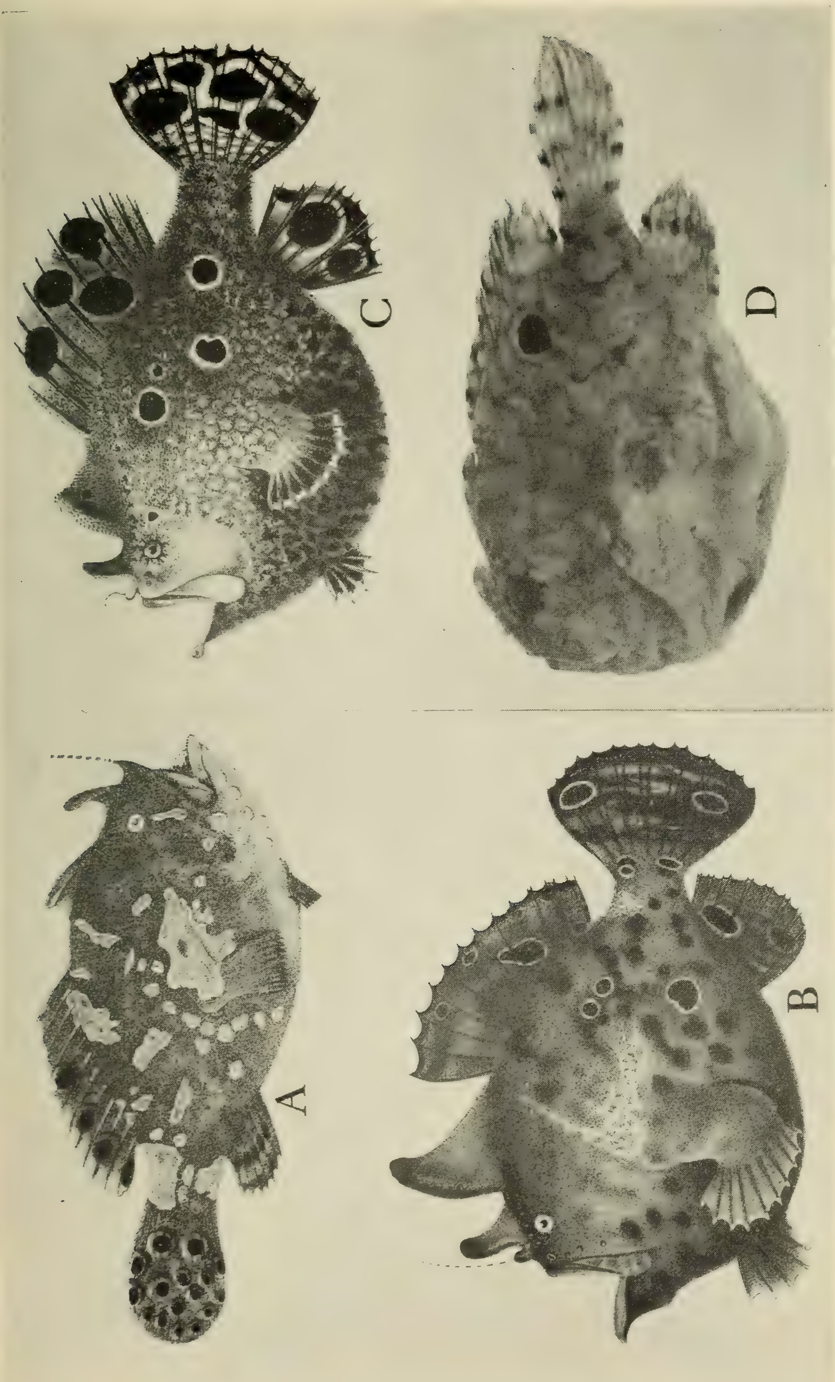
A, *Phyrnelox melas* (Bleeker), after Bleeker (Atlas, pl. 199, fig. 6). B, *Phrynelox güntheri* (Bleeker) may be *P. melas*, after Bleeker. C, *P. scaber* (Cuvier), after Poey 1853. D, *P. scaber* after Barbour 1942.



A, *Phrynelox cunninghami* (Fowler), after Fowler. B, *P. tridens* (Temminck and Schlegel), after authors. C, *Antennatus bigibbus* (Lacepède), after *Chironectes leprosus* Eydoux and Souleyet 1842. D, *A. bigibbus*, photo of CNHM 47648; first dorsal spine does not show.

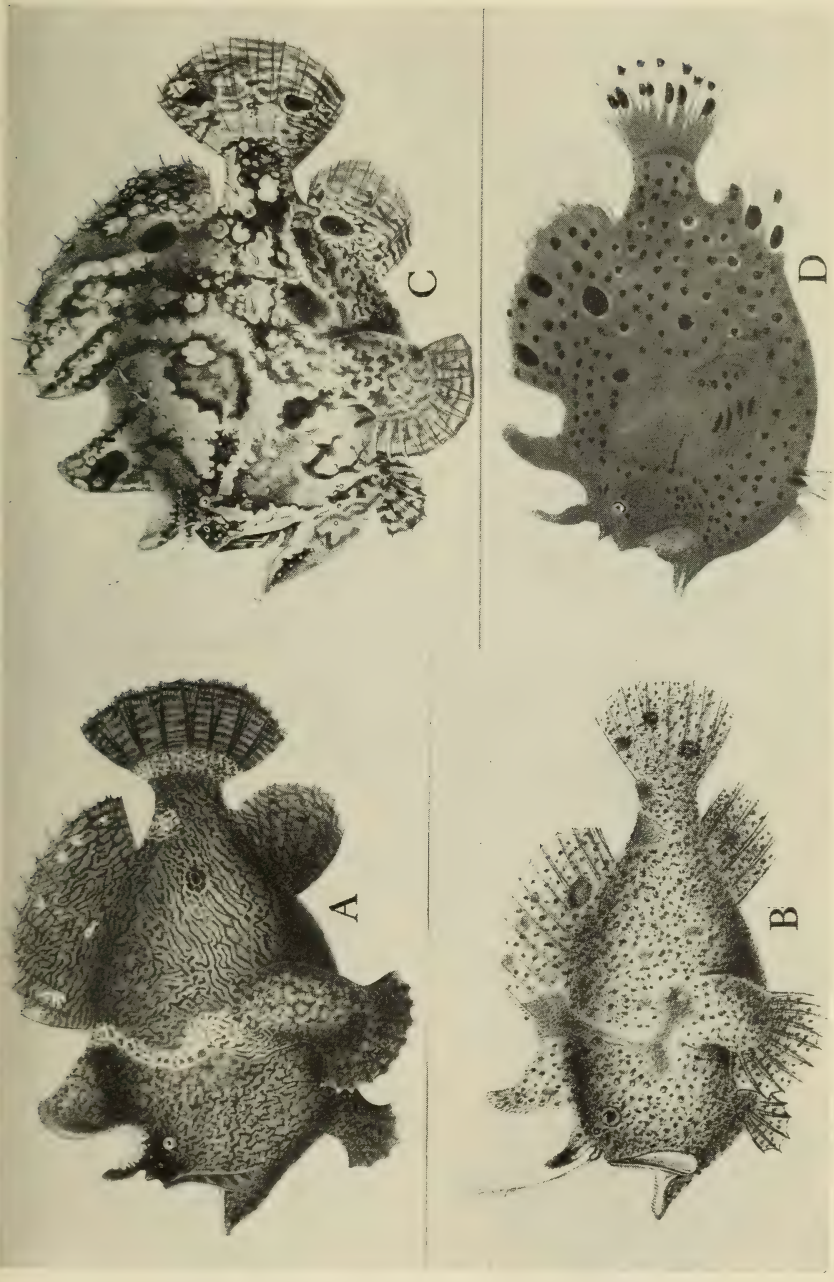


A, *Lophiocharon caudimaculatus* (Rüppell), after Bleeker. B, *Antennatus cryptacanthus* (Weber) after Weber. C, *A. strigatus* (Gill), photo of lectotype, USNM 6267. D, *Lophiocharon caudimaculatus*, photo of CNHM 21873.

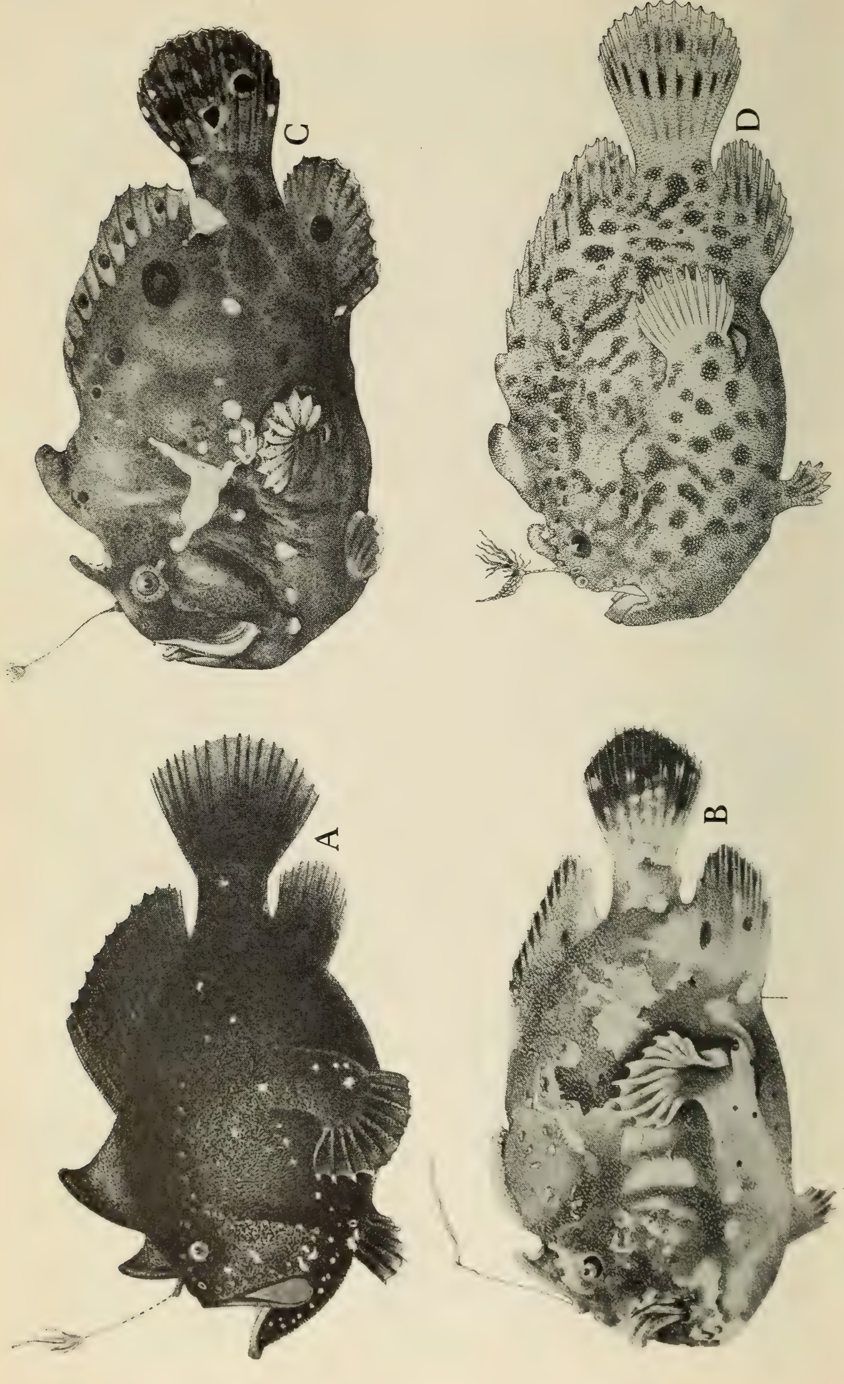


A, *Lophiocharon tenebrosus* (Poey), after Poey 1853. B, *L. horridus* (Bleeker), after Bleeker. C, *L. campylacanthus* (Bleeker), after Bleeker. D, *Antennarius radiosus* Garman, photo of USNM 155490.

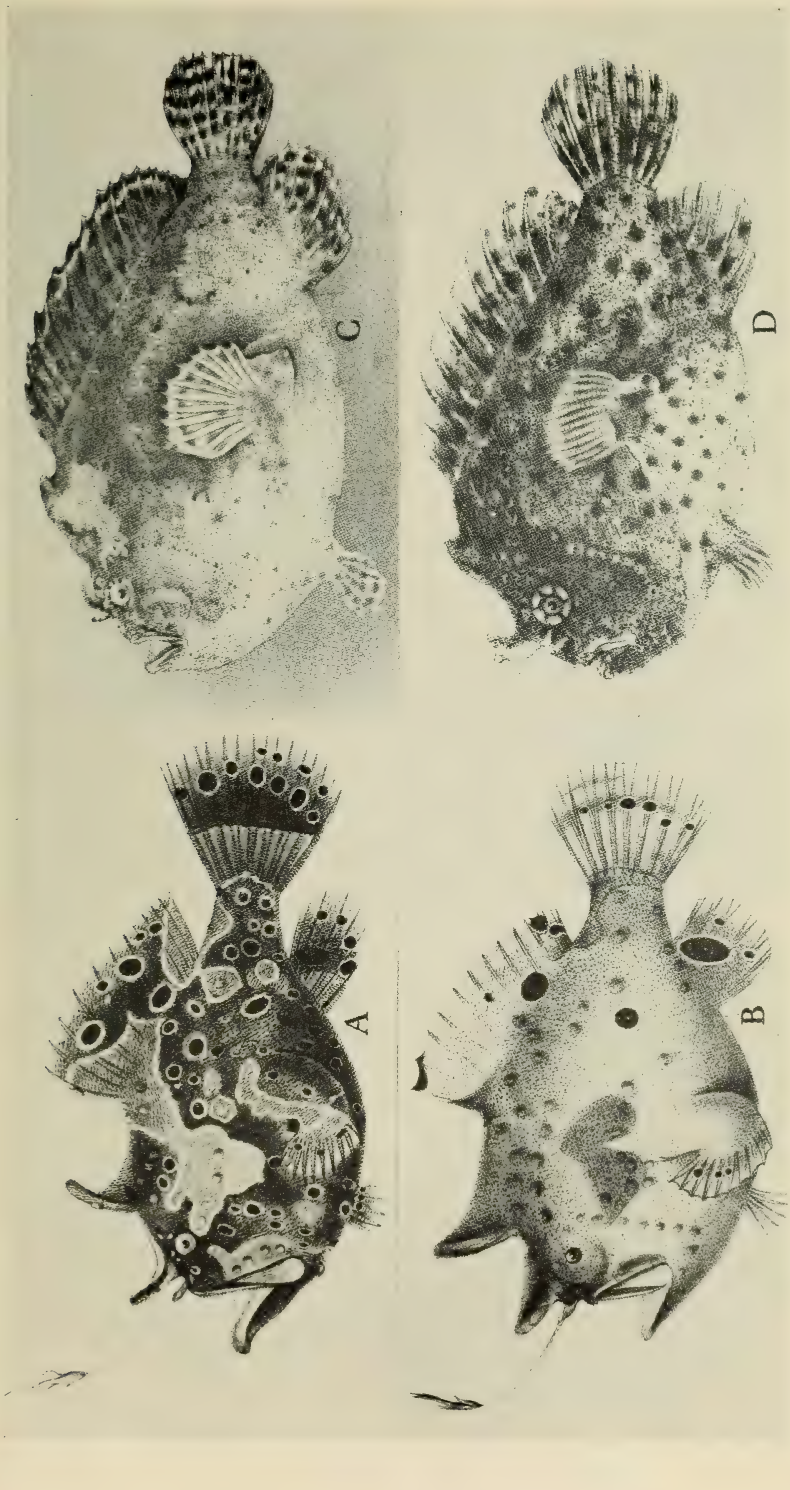
A, *Antennarius sarasa* Tanaka, after Tanaka. B, *A. ocellatus* (Bloch and Schneider), photo of CNHM 45696. C, *A. asper* Macleay, after Richardson. D, *A. hispidus* (Bloch and Schneider), after Bleeker.



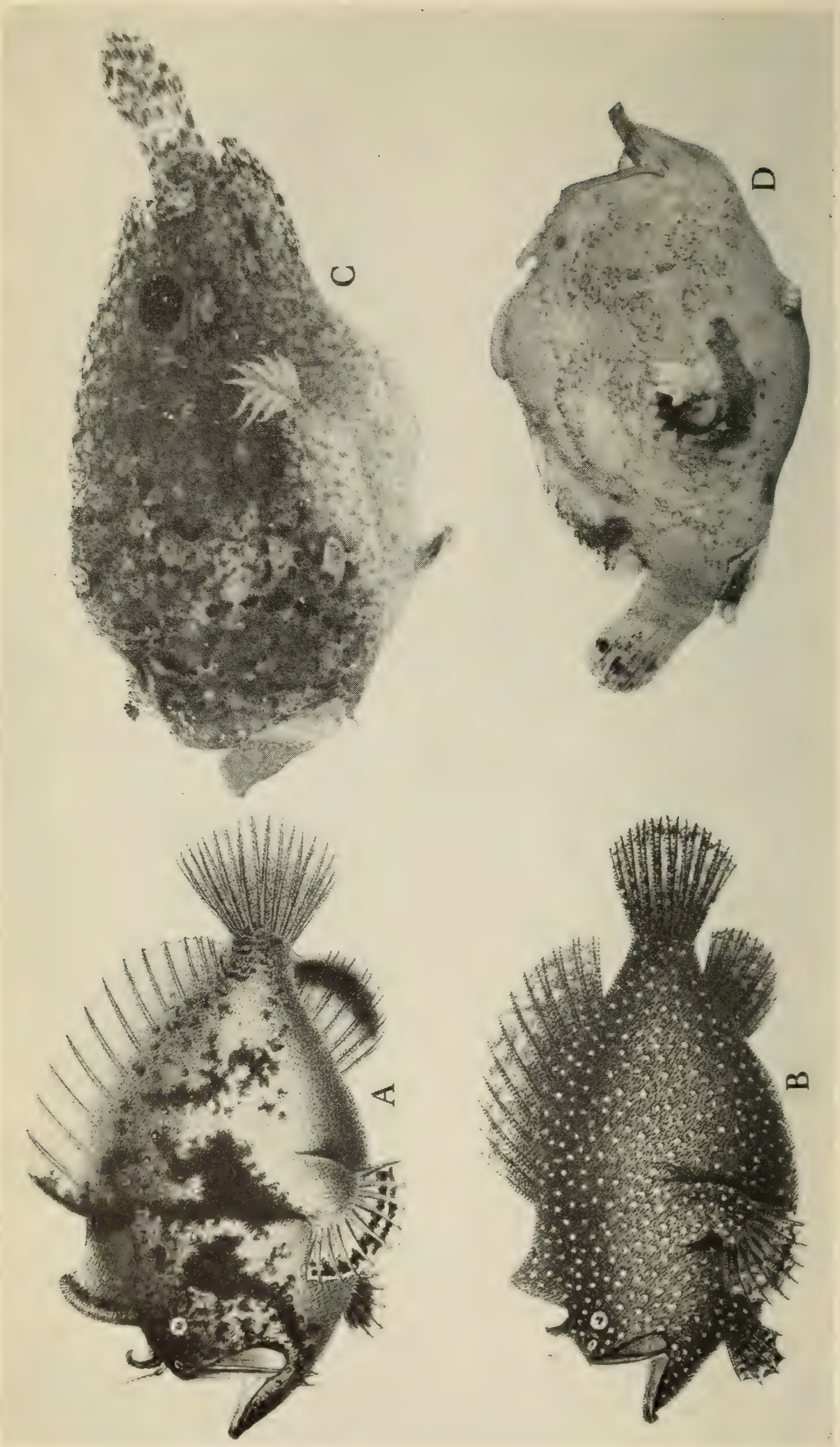
A and C, *Antennarius moluccensis* Bleeker (Atlas, vol. 5, pl. 196, fig. 2, and pl. 195, fig. 2). B, *A. leucosoma* Bleeker (Atlas, pl. 199, fig. 2). D, *A. pardalis* (Cuvier and Valenciennes), after authors.



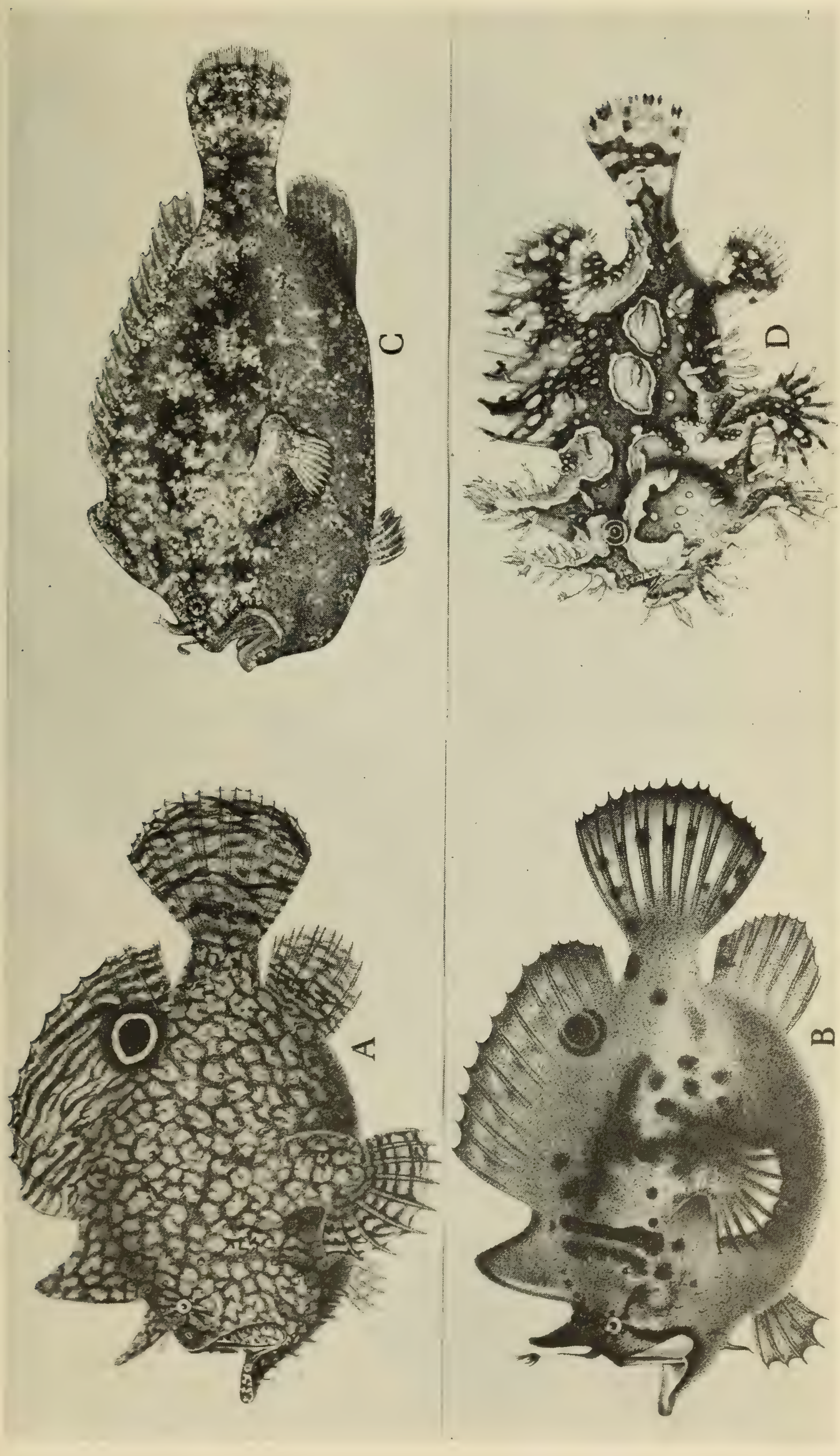
A and B, *Antennarius chironectes* Lacepède. A, black color phase after Bleeker (Atlas pl. 197 fig. 3); B, mottled color phase after Jordan and Evermann. C, *A. multiocellatus* (Cuvier and Valenciennes) after Barbour. D, *A. sanguineus* Gill, after Heller and Snodgrass.



A, *Antennarius phymatodes* Bleeker, after Bleeker. B, *A. oligospilos* Bleeker, after Bleeker. C and D, *A. drombus* Jordan and Evermann: C, after Snyder; D, holotype, after Jordan and Evermann.



A, *Antennarius coccineus* (Lesson), after Bleeker. B, *A. dorehensis* Bleeker, after Bleeker. C, *A. bermudensis*, new species, photo of paratype of CNHM 48862. D, *A. verrucosus* Bean, holotype, CNHM 4853, photo courtesy of Chicago Natural History Museum.



A and B, *Antennarius notophthalmus* Bleeker, both after Bleeker. C, *A. altipinnis*, photo of drawing in Philippine *Albatross* collection of USNM 150939. D, *Histrio histrio* Linnaeus, after Longley and Hildebrand.

A, *Kanazawaichthys scutatus*, new species; drawing by Mrs. D. B. Schultz of holotype, USNM 157919, from Gulf of Mexico. B, *Lophiocharon tenebrosus* (Poey); photo of USNM 174940, from Florida.

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NEW AMERICAN CYNIPID WASPS FROM OAK GALLS

By Lewis H. Weld

Twenty-three new species of cynipids are described herein; two are inquilines, while the others are gall makers. Twenty-one of these new species are from the United States, but two of the gall makers are from Mexico.

Types of the 23 new species are deposited in the U. S. National Museum. Paratypes are in institutions designated by the following abbreviations:

- AM: American Museum of Natural History.
- CM: Chicago Museum of Natural History.
- CA: California Academy of Sciences.
- PA: Academy of Natural Sciences of Philadelphia.
- C: Cornell University.
- MCZ: Museum of Comparative Zoology.

Genus *Synergus* Hartig

Synergus magnificus, new species

Female: Thorax black; head, except above antennae and on occiput, light-colored like legs and antennae; abdomen black or sometimes reddish. Vertex punctate, cheeks not broadened behind eyes, antennae 14-segmented, tapering to tip. Mesoscutum rugoso-coriaceous with a suggestion of transverse sculpture in low relief,

parapsidal grooves obsolete anteriorly, no median. Disk of scutellum rugose, pits transverse. Mesopleuron bare, entirely striate. Veins brown, areolet complete. Base of hind and middle coxae black. Abdomen longer than high, longer than head plus thorax, slightly gibbous at base. Big tergite deeply excavated behind in dorsal view so that four other tergites are visible in side view, lengths along dorsal margin as 35:9:7:6. Hind margin of big tergite and exposed parts of rest punctate, almost smooth in some individuals, VII pubescent, sheaths projecting. Length 3.4–6.05 mm. Average of 53 specimens, 4.74 mm.

MALE: Similar to female in color except that sides of pronotum and most of mesopleuron are not black, abdomen all black. Antennae 15-segmented, third very slightly excavated. Length 2.25–4.7 mm. Average of 74, 3.91 mm.

TYPES: USNM 63004, type female, allotype, and 10 paratypes. Paratypes in AM, CM, CA.

HABITAT: Guests in the ellipsoidal stem gall of *Disholcaspis truckeensis* (Ashm.) on *Quercus chrysolepis* Liebm. Types are from a series of 23 which emerged in April 1923 from galls collected at Idyllwild, Calif., in September 1922. Thirteen paratypes emerged May 18, 1911, from galls collected at Kanawyer, Tulare County, Calif., on July 4, 1910; two are from Colfax, Calif., two from Kyburz, Calif., and two are from Oregon Caves, Oreg. Eighty-five were reared Apr. 24 to May 6, 1954, by Hugh B. Leech from galls collected at Mill Valley, Marin County, Calif.; these paratypes are in the California Academy of Sciences.

Genus *Ceroptres* Hartig

Ceroptres montensis, new species

FEMALE: Black; antennae brown, darker distally; legs light brown except for slight infuscation on base of coxae. Face pubescent with a median ridge and faint striae about mouth. Antennae 13-segmented, segments 3–5 subequal. Vertex bare. Pronotum and mesonotum coriaceous, dull, pubescent. Anterior and lateral lines smooth. Parapsidal grooves extending forward half-way, median groove shorter. Disk of scutellum finely rugose behind, pits at base indistinct, dull. Mesopleuron with a large, smooth, bare, polished area. Wing pubescent, cilia short, veins brown, areolet distinct, radial cell 2.3 times as long as broad. Claws simple. Abdomen longer than high, lengths of tergites II and III on dorsal margin as 25 : 45, III smooth, exposed parts of rest and sides of the hypopygium punctate, ventral spine twice as long as broad. Length 1.8–3.1 mm. Average of 42 specimens, 2.52 mm.

MALE: Antennae 15-segmented, third slightly shorter than fourth and not excavated. Abdomen short, tergites II and III as 24:38. Length 1.8–2.35 mm. Average of 23, 2.08 mm.

TYPES: USNM 63005, type, allotype and 12 paratypes. Paratypes in AM, CM, CA, PA, MCZ, C.

HABITAT: Guests in tan, smooth, ellipsoidal stem galls. The types are from a series reared Mar. 17, 1923, from galls of *Andricus reniformis* McC. and Egb. on *Quercus vaccinifolia* Kell., at Tahoe City, Calif. Paratypes are from Holland, Oreg., and Kyburz, Mount Wilson, and Idyllwild, Calif., from galls of *Disholcaspis truckeensis* (Ashm.) on *Quercus chrysolepis* Liebm.

Genus *Neuroterus* Hartig

Neuroterus floricomus, new species

FEMALE: Black; tibiae, tarsi, most of coxae and first three segments of antennae straw-yellow. Head coriaceous; from above broader than thorax, cheeks broadened behind eye, occiput concave; from in front broader than high, malar space one-sixth as long as eye, antennae 13-segmented. Mesonotum smooth, mesopleuron bare, smooth, bulging. Wing short-pubescent, ciliate, veins distinct, areolet reaching one-sixth way to basal. Abdomen sessile, collapsed, shorter than thorax, ventral spine short. Length 1.4–1.7 mm. Average of 11 specimens, 1.56 mm.

MALE: Head and abdomen black; antennae, thorax and legs pale yellow. Cheeks not broadened behind eyes. Antennae 14-segmented, third elongated and slightly bent. Length 1.9–2.05 mm. Average of 7, 1.98 mm.

TYPES: USNM 63006, type female, allotype, and 2 paratypes. Other paratypes in AM, CM, CA.

HOST: *Quercus reticulata* Humb. & Bonpl.

GALL (pl. 1, fig. 5): On staminate flowers in late June. A densely woolly enlargement of the axis up to 25 mm. long by 10 mm. in diameter with only the anthers protruding.

HABITAT: The type material (Hopkins No. 15618[d]) was collected June 28, 1918, in the Santa Catalina Mountains, Ariz., and adults emerged up to July 9. Galls were seen in the Santa Catalina Mountains on *Quercus oblongifolia* Torr. and *Q. arizonica* Sarg., in the Huachuca Mountains on *Q. reticulata*, *Q. oblongifolia*, and *Q. arizonica*, in the Mule Mountains on *Q. arizonica*, and in the Chiricahua Mountains on *Q. arizonica* and *Q. toumeyi* Sarg.

Neuroterus lamellae, new species

FEMALE: Black except for light area about mouth, tibiae, tarsi, and three basal segments of antennae. Head microcoriaceous like thorax;

from above transverse, cheeks slightly broadened behind eyes; from in front malar space one-fourth of eye with a fine groove, antennae 13-segmented, the third longer than second or fourth. No parapsidal grooves. First abscissa of radius bent, areolet reaching one-sixth way to basal. Abdomen sessile, longer than thorax. Length 1.4–1.75 mm. Average of 10 specimens, 1.6 mm.

Types: USNM 63007, type and one paratype. Other paratypes in AM, CM, CA.

Host: *Quercus subturbinella*=*Q. turbinella* Greene.

Gall: A thickening of the parenchyma of a part of the leaf area, deforming the leaf, almost half an inch thick. Pubescence on lower side white and short, on upper side, where exit holes are located, it is longer. Resembles the gall of *Neuroterus washingtonensis* Beut. on *Quercus garryana* Dougl.

Habitat: Dead adults were cut out of galls in November 1944 from galls collected July 23, 1943, at Prescott, Ariz., by Mrs. N. W. Capron. As dark pupae were found in galls at Prescott on July 12, 1947, the normal emergence is probably in late July.

Neuroterus florulentus, new species

Female: Black, except for pale area about mouth and on antennae, tibiae, and tarsi. Head microcoriaceous like thorax; from above massive, cheeks as long as eye, slightly broadened behind eyes; from in front, malar space one-seventh as long as eye without groove, antennae 13-segmented, scape and pedicel swollen distally, third shorter than fourth. No trace of parapsidal grooves. First abscissa of radius arcuate, areolet small. Femora of normal shape, claws simple. Abdomen sessile, higher than long, ovipositor projecting straight out behind. Using width of the head as a base, the length of mesonotum ratio is 1.4, antenna 2.0, wing 4.6, ovipositor 1.7. Length 1.15–1.6 mm. Average of 24 specimens, 1.36 mm.

Male: Almost uniformly light-colored. Head massive, broader than thorax, cheeks greatly broadened behind eyes, antennae 14-segmented, scape and pedicel greatly elongated and obovate, third straight, last short, malar space without groove. Wing broadest one-third way from areolet to apex instead of midway as is usual. All femora greatly swollen on proximal two-thirds. Abdomen sessile, triangular, small. Length 1.15–1.7 mm. Average of 24, 1.36 mm.

Types: USNM 63008, type female, allotype, and 8 paratypes. Other paratypes in AM, CM, CA.

Hosts: *Quercus dumosa* Nutt. and *Q. lobata* Née.

Gall: Thin-walled, tan, ovate cells scattered singly or in small clusters among the staminate flowers, bearing at apex on either side the shrunken darker anthers. The base is truncate and excavated, unlike the gall of *N. floricola* Kinsey. Length 1.5 mm.

HABITAT: Types are from galls collected on flowers of *Quercus dumosa* Nutt., on Santa Catalina Island, Calif., Mar. 31, 1922, when adults were emerging. More emerged by April 10, and more came out and died by April 15. Similar galls were collected at Palo Alto, Calif., on May 3 on flowers of *Quercus lobata* Née, and some of the paratypes are from this lot.

Genus *Liodora* Foerster

Liodora dumosae, new species

FEMALE: Black; basal segments of antennae and legs beyond coxae pale. Head coriaceous; from above as broad as thorax, occiput concave, cheeks slightly broadened behind eyes; from in front malar space one-fourth as long as eye without groove, antennae 14-segmented. Mesocutum bare, smooth and shining except at anterior end of the percurrent grooves. Scutellum punctate, pubescent, overhanging propodeum behind in side view, pits smooth. Mesopleuron bare, smooth, polished. Wing pubescent, ciliate, veins brown, radial cell long and narrow, areolet faint. Claws with a tooth. Carinae on propodeum bent. Abdomen in side view higher than long, lengths of tergites on dorsal margin as 42:10:5:2. Ventral spine in side view hardly longer than broad. Using width of the head as a base, the length of antenna ratio is 2.35, ovipositor 1.4, wing 4.3. Length 1.4–2.2 mm. Average of 7 specimens, 1.75 mm.

MALE: Antennae 15-segmented, third to fourth as 16:11 and slightly bent. Abdomen small, pedicel 7, tergites II and III as 38:7. Length 1.5–1.75 mm. Average of 8, 1.68 mm.

TYPES: USNM 63009, type, allotype, and 2 paratypes.

HOST: *Quercus dumosa* Nutt.

GALL: Conical, thin-walled, 3 mm. long, erect, at margin of leaf, black when dry.

HABITAT: The types are from galls collected at Stanford, Calif., May 3, 1922, the adults emerging May 10. Paratypes are from Newhall, Lakeport, and Ukiah, Calif. Galls have been seen also on *Quercus douglasii* Hook. & Arn., *Q. lobata* Née, and *Q. garryana* Dougl.

Genus *Amphibolips* Reinhard

Amphibolips murata, new species

AGAMIC FEMALE: A concolorous amber species. Mesoscutum irregularly rugose without a distinct median groove and with faint transverse sculpture to right and left of anterior lines. Disk of scutellum coarsely rugose without a median depression, rounded behind; pits large with faint transverse sculpture, septum thin. Wing neither banded nor smoky but with a dark cloud on base of

radial cell. Cheeks bulging behind eyes. Abdomen almost globular, all the tergites visible, bare except for usual pubescence at base of II and on VII, hind margin of II and exposed parts of the rest finely punctate, ventral spine longer than hind metatarsus. Length 3.85–4.8 mm. Average of 20 specimens, 4.31 mm.

Belongs in a group that emerges from bud galls in late fall or in early spring from galls that have overwintered.

Types: USNM 63010, type and 4 paratypes. Other paratypes in AM, CM, PA.

Hosts.—Quercus myrtifolia Willd., *Q. pumila* Walt., *Q. laurifolia* Michx., and *Q. cinerea=Q. incana* Bartr.

Gall: A smooth, tan bud gall in the fall, from 8–12 mm. in diameter, tapering slightly to point of attachment, the thin-walled larval cell not free and separated from the thick, dense outer wall by a thin layer of spongy tissue (not radiating fibers). Adults are cut out of the galls in November; the only emergence records are December 4, December 8, and April 11.

Habitat: The type is from *Quercus myrtifolia* Willd. at Naples, Fla. Paratypes are from *Quercus myrtifolia* Willd. at Carrabelle, Fla.; *Q. pumila* Walt. at Ocala and Miami, Fla.; *Q. cinerea=Q. incana* Bartr., at St. Petersburg, Dade City, Sopchoppy, and River Junction, Fla.; and *Q. laurifolia* Michx. at Gainesville, Fla.

Genus *Andricus* Hartig

Andricus mendocinensis, new species

Female: Red; head, mesopleuron, and abdomen dorsally darker. Head from above transverse, cheeks broadened behind eyes, occiput not concave; from in front malar space finely striate, antennae 13-segmented. Mesonotum somewhat shining, punctate with appressed pubescence, parapsidal grooves percurrent, median extending forward one-third way. Pits on scutellum smooth. Mesopleuron bare, smooth. Wing pubescent, ciliate, first abscissa of radius angulate, areolet distinct. Claws with a strong tooth. Carinae on propodeum straight and parallel. Abdomen as high as long, tergites smooth, lengths along dorsal curvature as 20 : 10 : 9. Ventral spine longer than hind metatarus. Length 3.0 mm. Separated from *A. mamillaformis* (Weld), which has tergites punctate, mesopleuron striate in part, and disk rugose.

Type: USNM 63011, type. Paratype in CA.

Host: *Quercus densiflora=Lithocarpus densiflora* (Hook. & Arn.) Rehd., the tanbark oak.

Gall: An abrupt woody swelling about 30 mm. in diameter, thought to be a "root gall," containing many separable cells.

Habitat: Mendocino County, Calif. Collected May 29, 1917, by Dr. E. O. Essig. Described from two dead adults cut out of the gall at Stanford University in 1922. The gall can not now be located. If the host record is correct this is the first cynipid gall to be recorded on this host.

Genus *Disholcaspis* Dalla Torre and Kieffer

Disholcaspis edura, new species

Adults of *Disholcaspis* can hardly be described so as to be recognized from descriptions. The galls, however, are quite characteristic. The genus is known only from agamic females, reared in late fall from detachable stem galls on white oaks. No alternating generation has ever been recognized for any of the species. The only recognizable difference between this and the following species seems to be in color.

Agamic female: Head reddish brown like sides of pronotum and mesopleuron; antennae, tarsi, and abdomen darker. Eyes black, as are lateral lines and a large median area covering anterior parallel lines. Length 2.8–4.0 mm. Average of 33 specimens, 3.47 mm.

Types: USNM 63012, type and 8 paratypes. Other paratypes in AM, CM, CA, PA, C, and MCZ.

Hosts: *Quercus oblongifolia* Torr. and *Q. arizonica* Sarg.

Gall (pl. 1, fig. 1): A bullet gall in clusters of 3–6 on twigs, sessile, rounded at end, yellowish, up to 12 mm. in diameter. Larval cell basal, its wall unusually thick and hard, persisting after the soft distal tissue has weathered away.

Habitat: The types are from galls collected at Nogales, Ariz., Nov. 14, 1939, on *Quercus oblongifolia* Torr. Adults emerged Jan. 11 to Feb. 11, 1940. Paratypes are from galls collected at Magdalena, N. Mex., Nov. 9, 1921, then containing adults which emerged December 31. One paratype is from Patagonia, Ariz., and one from Oracle, Ariz. These galls have been noted also on *Quercus toumeyi* Sarg. and *Q. reticulata* Humb. & Bonpl.

Disholcaspis prehensa, new species

Agamic female: Similar in color to the preceding species. Length 2.65–3.35 mm. Average of 51 specimens, 2.99 mm.

Types: USNM 63013, type and 12 paratypes. Other paratypes in AM, CM, CA, PA, MCZ.

Host: *Quercus dumosa* Nutt.

Gall (pl. 1, fig. 8): Single or in groups of up to 25. Sessile with a smooth brown basal part clasping the twig, the top enlarged, rugose, dull and darker in color, probably secreting honeydew when young. Larval cell basal.

Habitat: The type is from galls collected in Sequoia National Park, Calif., on Sept. 9, 1922, when they contained full-grown larvae. Living adults were cut out Jan. 23, 1923. Paratypes are from Ukiah and St. Helena, Calif.

Disholcaspis mellifica, new species

Agamic female: Similar to *D. edura* (above) in color except that, never having emerged naturally, the abdomen is scarcely darker and the median dark area on mesonotum is not as large. It is also smaller than all the above species. Range in length, 1.85–3.0 mm. Average of 46 specimens, 2.71 mm.

Types: USNM 63014, type and 8 paratypes. Other paratypes in AM, CM, CA, PA.

Host: *Quercus garryana* Dougl.

Gall: Bursting out of cracks in the bark, usually in rows, like galls of *Callirhytis excavata* (Ashm.) but extending only one or two millimeters up above the flaps of bark. On current year's growth in fall, often on sprouts close to the ground. The top is flat, rugose, and secretes honeydew. Larval cell basal and occupying most of the interior, the only thick dense tissue being directly above. Single galls from above measure up to 3 by 5 mm., but those in a row are much distorted by mutual pressure.

Habitat: The types are from galls collected Sept. 8, 1922, above Cedar Creek checking station in Sequoia National Park, Calif. The galls then contained larvae and secreted so much honeydew that it dripped to the ground and in the sun was even evaporated to a white solid. Pupae were found in galls on October 1. Dead adults were cut out Mar. 17, 1923. This is the undescribed gall whose secretion has been described more fully by the author (Bull. Brooklyn Ent. Soc., vol. 20, p. 177, 1925).

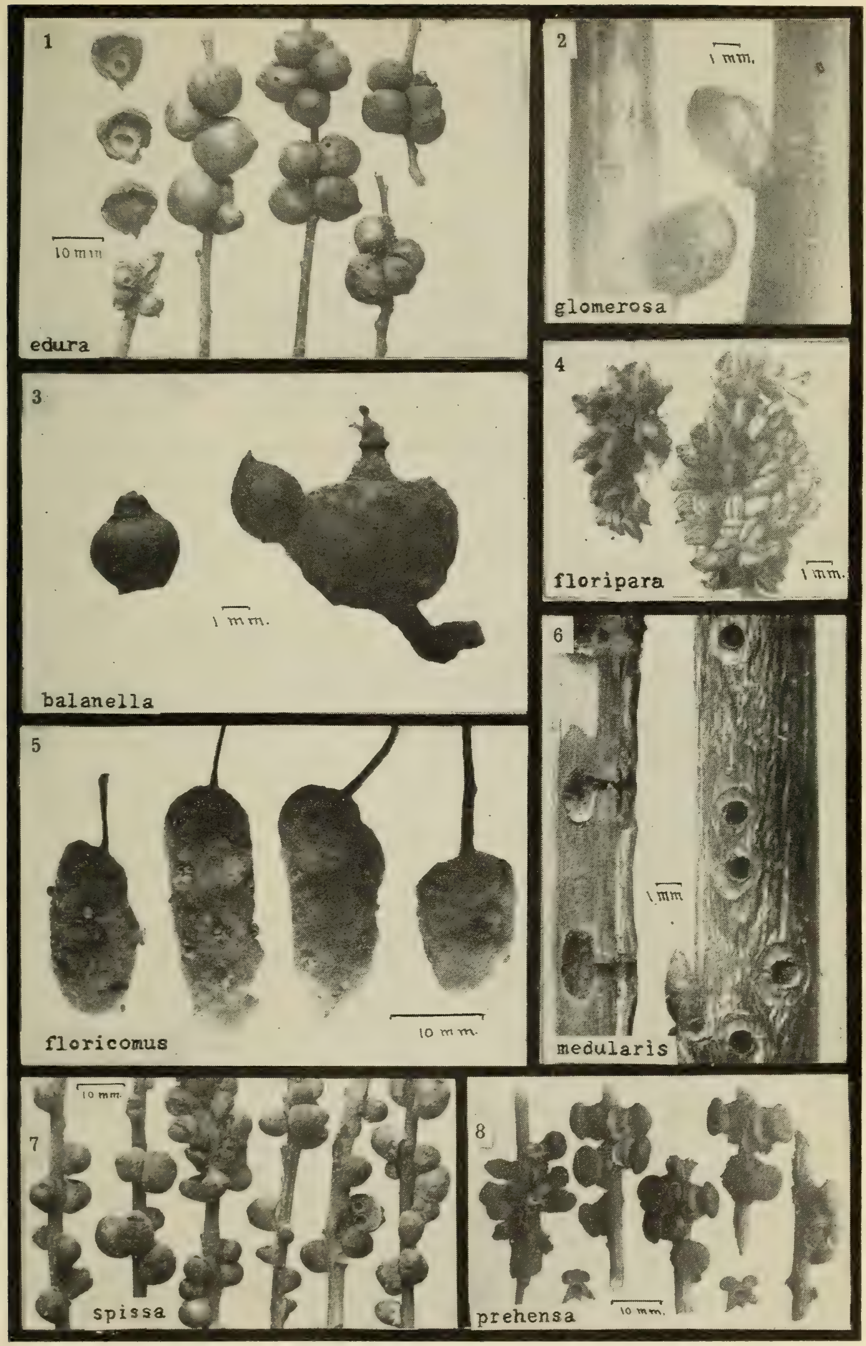
Disholcaspis spissa, new species

Agamic female: Similar in general coloration but darker than either of the three preceding species, having black on face below antennae, on vertex, proepisternum, mesosternum, metapleuron, propodeum, and dorsal abdomen. The black areas on mesoscutum and at base of scutellum are larger also. Length 2.45–3.6 mm. Average of 80 specimens, 2.98 mm.

Types: USNM 63015, type and 20 paratypes. Other paratypes in AM, CM, CA, PA, C, MCZ.

Hosts: *Quercus subturbinella*=*Q. turbinella* Greene, *Q. arizonica* Sarg., *Q. fendleri*=*Q. undulata* Torr., and *Q. havardi* Rydb.

Gall (pl. 1, fig. 7): Single or in dense clusters on twigs or rarely on the peduncle. Yellowish when young, brown with a dull matte



1, *Disholcaspis edura* on *Quercus oblongifolia;* 2, *Callirhytis glomerosa* on *Q. coccinea;* 3, *Callirhytis balanella* on *Q. emoryi;* 4, *Callirhytis floripara* on *Q. agrifolia;* 5, *Neuroterus floricomus* on *Q. reticulata;* 6, *Callirhytis medularis* on *Q. velutina;* 7, *Disholcaspis spissa* on *Q. subturbinella*=*Q. turbinella;* 8, *Disholcaspis prehensa* on *Q. dumosa.*

surface when mature. Sessile by a broad base, rounded and darker at apex, 6–7 mm. high. Larval cell basal, its wall thin, not free but imbedded in the dense cellular tissue of the distal part of the gall which is not cavernous as in *D. edura*.

Habitat: The type is selected from galls collected at Tijeras, N. Mex., Nov. 1, 1921. Many adults had emerged by December 31, and adults continued to come out until January 14. Paratypes are from galls on *Quercus arizonica* at Oracle and in the Chiricahua Mountains, Ariz.; from galls on *Q. fendleri*=*Q. undulata* Torr. at Shoemaker, N. Mex.; from *Q. subturbinella*=*Q. turbinella* Greene at Camp Creek, Ariz., and one from *Q. havardi* Rydb. at Sayre, Okla.

Disholcaspis mamillana, new species

Agamic female: Almost uniform amber except for the darker distal segments of antennae, metapleuron, tarsi, and dorsal abdomen. Length 2.8–3.3 mm. Average of 9 specimens, 3.1 mm.

Types: USNM 63016, type and two paratypes. Other paratypes in AM, CM, CA.

Host: *Quercus douglasii* Hook. & Arn.

Gall: A globular bullet gall drawn out at apex into a distinct blunt point like the pointed bullet gall of the Eastern States. Wall thick, central larval cell not separable. Covered when young with very dense, short pubescence which weathers away in late fall.

Habitat: The types were collected at Stanford, Calif., on Dec. 10, 1935, when they contained adults which had already chewed their way nearly to the surface. Galls were seen also at Paso Robles, Paraiso Springs, and Jolon, Calif.

Genus *Antron* Kinsey

Antron tepicana, new species

Agamic female: A light-colored species with the habitus of a *Disholcaspis*. Malar grooves absent, antenae 14-segmented. Parapsidal grooves percurrent, lateral lines smooth. Disk entirely finely rugose, dull. Wing pubescent, cilia short posteriorly, first abscissa of radius angulate, second heavy, enlarged at margin, basal heavy. A cloud at base of radial cell, on break of anal, at base of cubitus, and a large double one in distal end of cubital cell. Claws with a heavy tooth. Area between curved carinae on propodeum broader than high. Abdomen longer than high, tergites II and III pubescent on sides, II foliiform. Ventral spine broad, bristly, tapering suddenly into a triangular point. Length 3.5–5.25 mm. Average of 16 specimens, 4.63 mm.

Related to *A. nubila* (Ashmead) which is smaller, darker, and the two clouds in the cubital cell are not fused together. Differs from *A. chica* (Kinsey) in having no black on thorax, a larger areolet (reaching one-fifth way to basal), and in its larger size.

TYPES: USNM 63017, type and 3 paratypes. Other paratypes in AM, CM.

HOST: *Quercus reticulata* Humb. & Bonpl.

GALL: Similar to that of *A. chica* (Kinsey) (Indiana Univ. Publ., Sci. Ser. No. 4, fig. 151, p. 244, 1936), up to 60 mm. in diameter, the inner pile with transparent, tapering tips 5 mm. deep, the long outer crumpled hairs not swollen at the base. Larval cell up to 12 mm. high by 6 mm. in diameter.

HABITAT: Galls were collected Jan. 22, 1936, at Tepic, Mexico. Adults emerged and died in box before April.

Antron magdalenae, new species

AGAMIC FEMALE: Similar in color to the preceding species. Antennae 13-segmented. Cheeks broadened behind eyes, malar groove absent. Lateral lines and area between the percurrent parapsidal grooves smooth and shining. Disk coriaceous with a large smooth and shining transverse groove at base. Wing pubescent, cilia short. Tergite II foliiform, III bare. Ventral spine broad, bristly, tapering abruptly to a triangular apex. Using width of the head as a base, the length of mesonotum ratio is 1.47, antenna 2.4, wing 5.0, ovipositor 1.87. Length 2.45–3.1 mm. Average of 12 specimens, 2.81 mm. Differs from preceding species in its smaller size, fainter spots in cubital cell, and smooth base of disk.

TYPES: USNM 63018, type and two paratypes. Other paratypes in AM, CM.

HOST: *Quercus subturbinella*=*Q. turbinella* Greene.

GALL: Globular, 3 mm. in diameter, with a dull, uneven surface covered with stellate hairs, sessile by a broad base on under side of leaf in the fall. Wall thin.

HABITAT: The types were cut out November 10 from galls collected Nov. 9, 1921, at Magdalena, N. Mex. Two paratypes are from Tijeras, N. Mex. Galls were seen also at Hillsboro, Kingston, and in the Burro Mountains, N. Mex.

Genus *Loxaulus* Mayr

Loxaulus beutenmuelleri, new species

FEMALE: Amber, abdomen darker posteriorly. Head coriaceous; from above massive, broader than thorax, slightly broadened behind eyes; from in front malar groove present, antennae 13-segmented.

Sides of pronotum with faint, irregular ridges. Mesoscutum coriaceous, parapsidal grooves obsolete anteriorly, no median. Disk rugose with a sculptured groove at base. Mesopleuron coriaceous. Pubescence and cilia on wing short, both cross-veins clouded. Claws simple. Carinae on propodeum almost straight, diverging slightly above, a distinct median present. Abdomen not as long as thorax, lengths of tergites along dorsal margin as 38 : 12 : 4. Ventral spine about twice as long as broad. Length 1.45–2.15 mm. Average of 32 specimens, 1.83 mm.

Types: USNM 63019, type and 7 paratypes. Other paratypes in AM, CM, CA.

Host: *Quercus borealis*=*Q. rubra* L., northern red oak.

Gall: Probably a midrib cluster.

Habitat: The type is selected from a series reared from galls collected by William Beutenmueller at Fort Lee, N. J., Oct. 21, 1916, and sent to me for rearing. They were picked up on the ground under a red oak tree and thought at the time to be galls of *Dryocosmus piperoides* (Bass.). Adults emerged Apr. 6, Apr. 22, and May 11, 1918. Paratypes are from what were thought to be all galls of *D. piperoides* picked up at the Chicago River west of Evanston, Ill., on Oct. 8, 1916. Adults emerged April 22–May 28, 1918, and some were *D. piperoides* (Bass.). One was captured at Vienna, Va., Apr. 29, 1945. Three are from Washtenaw County, Mich., May 13, 1951 (R. R. Dreisbach).

Genus *Callirhytis* Foerster

Callirhytis balanella, new species

Female: A light brown species with dorsal abdomen darker. Head from above transverse, cheeks bulging behind eyes, occiput concave; from in front broadest above middle of eyes, antennae 13-segmented, twice as long as width of head. Mesoscutum with short, appressed pubescence, granulate with slight transverse sculpture posteriorly, parapsidal grooves obsolete anteriorly, anterior and lateral lines not infuscated. Scutellum disk transversely sculptured, pits smooth. Mesopleuron pubescent, with spaced, curved ridges. Wing hyaline, almost bare, nonciliate, areolet reaching one-fifth way to basal, first abscissa of radius angulate. Claws simple. Carinae on propodeum slightly bent. Abdomen longer than high, all tergites showing on dorsal curvature. Ventral spine as long as hind metatarsus. Length 3.4 mm. Belongs in Group A of *Callirhytis*. Nearest related species are eastern.

Types: USNM 63020, type. One paratype in CA.

Host: *Quercus emoryi* Torr.

Gall (pl. 1, fig. 3): Similar to a "pip" gall in shape but produced on the side of the cup of an undersized acorn in June and July. Gall slightly flattened, 4 mm. high by 3 mm. in diameter.

Habitat: The type and one paratype are from galls collected at Cherry, Ariz., by Mrs. N. W. Capron on Oct. 4, 1935. One adult emerged April 23 and the other May 1, 1937. One paratype is from a gall Mrs. Capron collected at Prescott, Ariz., Sept. 12, 1950, and the living adult was cut out Apr. 11, 1952. Galls were seen in the Santa Catalina and Huachuca Mountains and at Patagonia, Nogales, and Bisbee, Ariz., and at Alpine, Tex.

Callirhytis floripara, new species

Female: Light brown, head darker, antennae and legs straw-yellow. Head coriaceous; from above transverse, as broad as thorax, slightly broadened behind eyes; from in front malar space about half as long as eye without groove, antennae 13-segmented. Mesoscutum coriaceous, parapsidal grooves percurrent, broader behind. Disk pebbled, from rear rugose, pits deep, smooth. Mesopleuron bare, striate. Wing hyaline, dotted, nonciliate, veins beyond second cross-vein pale. Claws small, simple. Carinae on propodeum slightly curved. Abdomen shorter than head plus thorax, lengths of tergites on dorsal curvature as 32:7:2. Tergite II smooth. Ventral spine three times as long as broad in side view. Using width of head as a base, the length of mesonotum ratio is 1.1, antenna 2.3, wing 4.0, ovipositor 2.5. Length 1.1–1.5 mm. Average of 100 specimens, 1.27 mm.

Male: Almost black with antennae and legs yellow. Antennae 14-segmented, the third longest and slightly bent. Wing ciliate. Length 0.95–1.35 mm. Average of 100 specimens, 1.21 mm.

The well-developed second abscissa of radius and a distinct cubitus distinguish this from the other species in Group B reared from flower galls.

Types: USNM 63021, type female, allotype, and 10 paratypes. Other paratypes in AM, CM, PA, C, CA.

Host: *Quercus agrifolia* Née.

Gall (pl. 1, fig. 4): A thin-walled, conical, tan gall measuring up to 2.2 mm. long by 1.0 mm. in diameter, developed from a filament and bearing distally trace of a shriveled anther, scattered in among normal stamens in a much-shortened inflorescence.

Habitat: The types are from galls collected from a tree of *Q. agrifolia* Née at Carpinteria, Calif., on Apr. 29, 1918, when adults were emerging in large numbers and when adults (probably these) were observed ovipositing in young acorns. Adults continued to emerge until May 18 in material sent to Washington as "Hopk. U. S. No. 15606[d]." This tree also had galls of *Callirhytis carmelensis*

Weld on acorns of the previous season. These flower galls were seen also at Paso Robles and Monterey, Calif., on trees which had *C. carmelensis* also, circumstantial evidence that this is the alternating generation of that species.

Callirhytis glomerosa, new species

FEMALE: Amber. Head from above transverse, narrower than thorax (48:50), occiput concave; from in front broader than high, cheeks broadened behind eyes, no malar groove, striate and pubescent about mouth, antennae 13-segmented. Mesoscutum almost bare, coriaceous, parapsidal grooves percurrent, broader and deeper behind, a median present posteriorly as a groove or as discontinuous punctures. Scutellum coriaceous behind the pits, rugose peripherally. Mesopleuron almost bare, coriaceous above, striate below. Wing hyaline, dotted, nonciliate, radial cell open at base, cubitus barely visible. Carinae on propodeum slightly bent. Abdomen with an interrupted ring of tangled pubescence at base with similar patches on sides of propodeum, metapleura, and hind coxae, all the tergites visible, the posterior ones punctate, ventral spine longer than hind metatarsus. Using width of head as a base, the length of mesonotum ratio is 1.1, antenna 2.1, wing 3.64, ovipositor 3.5. Length 1.8–2.05 mm. Described from four specimens, one on slide.

TYPES: USNM 63022, type and one paratype.

HOST: *Quercus coccinea* Muenchh.

GALL (pl. 1, fig. 2): A smooth greenish or brownish (in sun) bud gall in September or October about 3 mm. in diameter, over half of it projecting beyond the bud scales, dropping when full-grown and then slightly pubescent at the base. Adults emerge the second spring.

HABITAT: The type is from a gall collected at East Falls Church, Va., in late September 1933 and the adult cut out Oct. 16, 1934. Paratypes are from Vienna and Alexandria, Va. Similar galls have been seen on northern red oak, Spanish oak, and on *Quercus ilicifolia* Wangenh. Not in type series is one from Baldwin County, Kans., collected in May by J. C. Bridwell.

Callirhytis intersita, new species

FEMALE: Reddish brown; antennae, face in part, and legs beyond coxae light yellow. Head finely rugose; from above transverse, cheeks broadened behind eyes, occiput concave; from in front malar space striate, antennae 14-segmented. Sides of pronotum rugose. Mesoscutum broader than long, bare, transversely rugose, the parapsidal grooves obsolete anteriorly. Disk of scutellum entirely rugose, pits with longitudinal ridges. Mesopleuron rugose above and below a coriaceous area. Wing short-pubescent, nonciliate, veins clear, no

areolet. Claws simple. Abdomen as long as head plus thorax, as high as long, tergites shining, III–VI finely punctate, lengths as 60:18:18:4:3. Ventral spine very short. Length 2.1–2.75 mm. Average of 18 specimens, 2.44 mm.

Distinguished from *C. lapillula* Weld whose parapsidal grooves are percurrent with face coriaceous instead of rugose below the median ocellus.

Types: USNM 63023, type and 4 paratypes. Other paratypes in AM, CM.

Host: *Quercus alba* L.

Gall: Unknown. These were taken ovipositing in the internodes of the green new growth of white oak twigs on April 25, 29, and May 5. What gall resulted, if any, is not known. There are cells in the pith of white oak twigs, but fragments of the only dead adults cut out so far are different from these.

Habitat: The type is selected from adults taken ovipositing at Vienna, Va., on Apr. 29, 1945. Paratypes are from East Falls Church, Va., Apr. 25, 1941, and May 5, 1946.

Callirhytis manni, new species

Female: Light red, mesopleura and propodeum darker. Head coriaceous but rugose above and below antennae; from above transverse, broader than thorax, cheeks bulging behind eyes, occiput concave; from in front, malar space not striate, antennae 14-segmented. Sides of pronotum striate. Mesoscutum bare, finely pebbled, parapsidal grooves percurrent, anterior lines smooth. Disk of scutellum coriaceous back of the smooth pits, rugose peripherally. Mesopleuron bare, coriaceous. Wing pubescent, ciliate, veins brown, first abscissa of radius angulate, areolet distinct. Claws simple. Abdomen shorter than head plus thorax, as high as long, tergites smooth, lengths as 65 : 15, ventral spine 3–4 times as long as broad. Length 2.5–2.85 mm. Average of 7 specimens, 2.58 mm. Distinguished from *C. suttoni* (Ashmead) which has mesonotum pubescent and punctate.

Types: USNM 63024, type and one paratype. Other paratypes in AM, CM.

Host: An undetermined oak.

Gall: A spindle-shaped woody stem swelling similar to the gall of *Callirhytis floridana* (Ashmead).

Habitat: The types are from galls collected Jan. 22, 1935, at Tepic, Mexico. Adults emerged in packet. Dr. William Mann collected these galls in March 1923.

***Callirhytis medularis*, new species**

FEMALE: Amber, abdomen and hind tibiae darker. Head coriaceous; from above massive, broader than thorax, cheeks bulging behind eyes, occiput concave; from in front malar space faintly striate above groove, antennae 13-segmented. Mesoscutum transversely rugose, less coarsely so anteriorly, parapsidal grooves percurrent, no median. Scutellum rugose, the sculptured groove at base with indistinct septum. Mesopleuron bare, coriaceous. Wing dotted, nonciliate, veins clear beyond second cross-vein, no areolet. Claws simple. Carinae on propodeum diverging slightly behind. Abdomen as long as head plus thorax, tergite II bare at base, reaching back half-way, its hind margin and exposed parts of rest coriaceous. Ventral spine very short, valves exserted. Using width of the head as a base, the length of mesonotum ratio is 1.2, antenna 2.2, wing 3.15, ovipositor 8.7. Length 2.2–2.9 mm. Average of 25 specimens, 2.37 mm.

MALE: Body dark; antennae, parts of head, and legs amber. Antennae 15-segmented, tapering to tip, third strongly bent and almost as long as fourth. Wing pubescent and ciliate. Abdomen shorter than thorax, lengths of tergites on dorsal margin as 47 : 10 : 3, exposed part of III coriaceous. Length 1.25–2.0 mm. Average of 40 specimens, 1.55 mm.

Belongs in Group B of *Callirhytis*. Ruled out of *Bassettia* by its short ventral spine and bare base of abdomen. The sculpture suggests that this may be the sexual generation of a species making stone galls in acorns. The unusually long ovipositor also suggests this.

TYPES: USNM 63025, type female, allotype, and 6 paratypes. Other paratypes in AM, CM, PA, C.

HOSTS: *Quercus borealis*=*Q. rubra* L., *Q. velutina* Lam., and *Q. coccinea* Muenchh.

GALL (pl. 1, fig. 6): Cells are in the pith of current year's growth of various red oaks with no visible evidence until exit holes are noticed, when it is too late to secure adults. Synergus and three species of chalcids emerged the next spring, April 27 to May 3.

HABITAT: The types are selected from a series of 16 females and 35 males reared by Dr. F. C. Craighead near Blain, Pa., from twigs of northern red oak, the males emerging July 15 to July 24, the females July 16 to Aug. 1, 1956, from current season's growth. He had cut out dead males and females in August 1955. Four paratypes were cut out of twigs of scarlet oak in August 1950 at Cincinnati, Ohio,

by R. B. Neiswander. From black oak are two paratypes from Vienna, two from Williamsburg, and one from East Falls Church, Va.

Nurseries at Cincinnati, Ohio, and at Southampton, Pa., reported that leaders of pin and scarlet oaks broke off where weakened by many exit holes causing lateral branches to form, resulting in poor-headed trees. The landscape superintendent at Williamsburg, Va., reported branches 12-18 inches long breaking off there. Similar cells in the pith of willow oak were noted at Durham, N. C., where 200 terminal twigs, weakened by exit holes, had been broken off or left hanging on one tree on the Duke University campus. Similar cells occur in the pith of twigs of red oak in Missouri and in blackjack and scrub oak in Virginia.

Callirhytis perobscura, new species

Female: Reddish brown to black, base of abdomen red, legs, except hind and middle coxae, and antennae brown. Head rugose; from above transverse, cheeks broadened behind eyes, occiput slightly concave; from in front malar space 0.3 of eye, antennae 14-segmented. Sides of pronotum and propleura rugose. Mesoscutum beautifully coriaceous, parapsidal grooves percurrent, anterior and lateral lines sunken, median extending to middle of anterior lines. Disk of scutellum rugose, pits with longitudinal ridges. Wing pubescent, nonciliate, venation complete, first abscissa of radius angulate. Claws simple. Abdomen longer than high, shorter than head plus thorax, bare at base, lengths of tergites as 33:7, hind margin of II and exposed part of III finely coriaceous. Ventral spine short. Length 3.5–4.25 mm. Average of 15 specimens, 3.93 mm.

Belongs in Group C, the root gall group, near *C. marginata* Weld, from which it is distinguished by its longer median groove and sunken anterior and lateral lines.

Types: USNM 63026, type and 3 paratypes. Other paratypes in AM, CM, PA.

Host: *Quercus velutina* Lam.

Gall: Unknown.

Habitat: The types were taken ovipositing in buds at East Falls Church, Va., on Apr. 18 and 20, 1927, Apr. 22, 1930, Apr. 23, 1932, Apr. 23, 1947, and at Takoma Park, Md., on Apr. 13, 1925.

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THE FORAMINIFERAL GENUS HALYPHYSEMA AND TWO NEW TROPICAL PACIFIC SPECIES

By Alfred R. Loeblich, Jr.

The peculiar foraminiferal genus *Halyphysema*, originally described by Bowerbank from the coast of England as a sponge, is redescribed and refigured, and a lectotype designated for the type species. Two new species from the tropical Pacific, *H. harryi* from Ifaluk Atoll, Caroline Islands, and *H. bayeri* from the Palau Islands are described. The genus is without doubt abundantly represented in shallow tropical waters of the Pacific, but is generally overlooked by students of Foraminifera because collecting necessitates a detailed search of coralline rocks and other substrata for "colonies." Rarely will such a form be obtained in dredged material. The present paper extends the geographic range of the genus into the Central Pacific area.

The writer is indebted to Dr. Robert R. Harry, research director of George Vanderbilt Foundation, Stanford University, Calif., and to Mr. Frederick M. Bayer of the U. S. National Museum for their interest and enthusiasm in collecting this material, especially as it is far from their own special interest.

Genus *Halyphysema* Bowerbank, 1862

Halyphysema Bowerbank, Philos. Trans. Roy. Soc. London, vol. 152, p. 1105, 1862.

Type species: *Halyphysema tumanowiczii* Bowerbank, 1862. Fixed by monotypy.

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Description: Test attached, commonly to bryozoans, hydrozoans, or other substrata, and consisting of a spreading basal expansion with a later erect conical or club-shaped portion formed by the single chamber, in some species the chamber may bifurcate; wall agglutinated, that of the basal expansion fine grained and including small fragments of sponge spicules, erect portion commonly more coarsely grained with very numerous, elongate spicules incorporated into the wall and alined in the direction of growth of the test; aperture terminal, commonly rounded, obscured by the clustering of spicules.

Remarks: *Halyphysema* differs from *Dendronina* Heron-Allen and Earland in having a single conical chamber, instead of an arborescent, branching, nonseptate tube following the development of the basal expansion.

Halyphysema tumanowiczii Bowerbank

Plate 1, Figures 1, 2

Halyphysema tumanowiczii Bowerbank, Phil. Trans. Roy. Soc. London, vol. 152, p. 1105, pl. 73, fig. 3, 1862.

Squamulina scopula Carter, Ann. Mag. Nat. Hist., ser. 4, vol. 5, p. 310, pl. 4, figs. 1–11, 1870.

Description: Test attached, forming a series of hemispherical bases, each of which gives rise to a single clavate chamber; wall agglutinated, with small sand grains and spicules in the basal expansion, clavate chambers in large part composed of sponge spicules, their long axes paralleling the surface, elongate sponge spicules clustered around the distal end of the clavate chambers giving the test a bristling appearance; aperture terminal, not visible, obscured by the cluster of spicules.

Length of chamber of lectotype 1.10 mm., breadth of basal expansion 0.25 mm.

Remarks: This species was originally described as a sponge and later was renamed *Squamulina scopula* by Carter (1870), who thought

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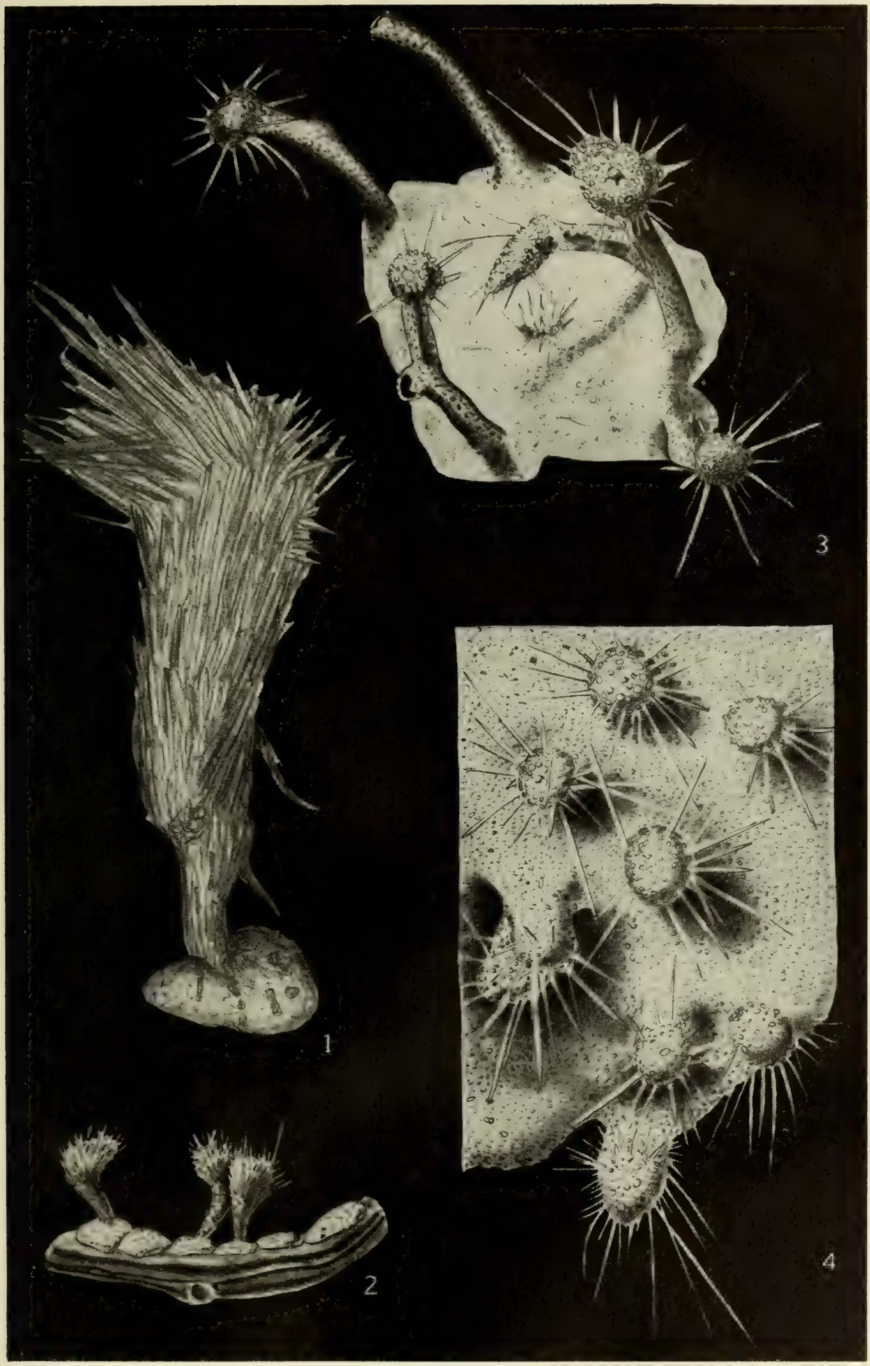
Explanation of Plate 1

Figure 1.—*Halyphysema tumanowiczii;* side view of lectotype (BMNH ZF3652) showing flaring shape of chamber and wall composed largely of sponge spicules. (× 85.)

Figure 2.—*Halyphysema tumanowiczii;* side view of several paratypes showing small hemispherical basal expansions, each with an individual chamber. The chambers have been broken from some of the expansions, but scars show they were formerly present. From the Recent, off England. (× 25.)

Figure 3.—*Halyphysema bayeri*, new species; holotype (USNM P5901) showing spreading, sheetlike basal expansion and long, slender, flexible chambers that commonly bifurcate near their distal ends. From the Recent, Palau Islands. (× 25.)

Figure 4.—*Halyphysema harryi*, new species; holotype (USNM P5900) showing spreading sheetlike basal expansion and low, nearly cylindrical chambers. From the Recent, Ifaluk Atoll, Caroline Islands. (× 25.)



Halyphysema tumanowiczii; H. bayeri, new species; and *H. harryi*, new species. For explanation see facing page. All figures are camera lucida drawings. Figure 1 is by Helen N. Loeblich, and figures 2–4 are by Lawrence B. Isham, scientific illustrator at the Smithsonian Institution.

that this would remove the species from consideration as a sponge! It is not congeneric with *Squamulina* Schultze, however, as the latter is a calcareous imperforate form. Carter's specific name is a junior synonym of that of Bowerbank.

Types and occurrence: Specimens figured are from the original types in the British Museum (BMNH ZF3652), lectotype from Recent beach debris at Hastings, County Sussex, England.

Halyphysema bayeri, new species

Plate 1, Figure 3

Description: Test attached, in the type specimens encrusting on an alcyonarian base, forming a broad, thin, basal expansion from which arise one to six or more individual, erect, flexible, slender chambers that are expanded and knob-shaped at their distal end and commonly may bifurcate near their distal end; wall agglutinated, thin, 0.02 mm. in diameter in erect chambers, that of basal expansion and erect chambers composed of small sand grains and fragmentary sponge spicules in a groundmass of fine grains, spicules oriented with long axes paralleling the surface, elongate sponge spicules incorporated around the apertures at the terminal end of the erect chambers; aperture terminal, 0.08 mm. in diameter.

Diameter of individual chambers at distal end ranges from 0.23 to 0.38 mm., diameter at midlength of erect chamber ranges from 0.10 to 0.13 mm. Distance between chambers ranges from 0.28 to 1.30 mm.

Remarks: *Halyphysema bayeri*, new species, differs from *H. harryi*, new species, from Ifaluk Atoll, Caroline Islands, in possessing chambers that are much more slender, flexible, and elongate. It is similar in general appearance to *H. advena* Cushman described from the Tortugas, but is smaller in size. The present species has a tendency for the individual chambers to bifurcate near their distal part, and the base is sheet-like instead of forming small hemispherical masses as in *H. advena* Cushman.

The species is named in honor of Frederick M. Bayer, zoologist, U. S. National Museum, in recognition of his contributions to the knowledge of the Pacific atolls.

Types and occurrence: Holotype (USNM P5901) from eel-grass, sand, and coral flat in Geruherugairu-suidô, between Kaibakku Island and Kogai-hantô of Auluptagel, Iwayama Bay, Palau Islands. U. S. Hydrographic Office chart 6076, 2d ed., 1944, lat. 7°19′12″ N., long. 134°29′37″ E. Depth 0–3 feet. Collected by Frederick M. Bayer and Robert R. Harry, 1955.

Halyphysema harryi, new species

Plate 1, Figure 4

Description: Test attached, on coralline-algal rock, forming a broad, spreading basal expansion from which arise individual erect, clavate-shaped, single chambers, rarely narrowing to a fusiform shape or more rarely low and blister-like, may bifurcate near the distal end; wall agglutinated, relatively thick, 0.03 mm. in diameter in erect chambers, that of basal expansion and single chambers including fine grains of sand and fragmentary sponge spicules, their long axes paralleling the surface, elongate sponge spicules incorporated at the terminal ends of the chambers giving a bristling appearance; aperture terminal, not observed on specimens examined due to small size and the obscuring by the terminal spicules.

Diameter of individual chambers ranges from 0.15 to 0.40 mm. Distance between chambers varies from 0.20 to 0.70 mm.

Remarks: *Halyphysema harryi*, new species, differs from *H. tumanowiczii* Bowerbank in possessing individual chambers that are usually lower and of equal diameter throughout length and in the tendency to develop a broad, spreading, basal expansion from which rises many chambers, instead of a small hemispherical base from which arises a single chamber.

The specific name is in honor of Robert R. Harry, research director at George Vanderbilt Foundation, Stanford University, Calif., in recognition of his interest and devotion to studies of Pacific marine life.

Types and occurrence: Holotype (USNM P5900) from the underside of élang (boulder flat) boulders, south end Falarik Island, Ifaluk Atoll, Caroline Islands. Collected Oct. 31, 1953, by Frederick M. Bayer.

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THE LEAFHOPPER TRIBE ALEBRINI (HOMOPTERA: CICADELLIDAE)

By David A. Young, Jr.[1]

The last taxonomic treatment of the species of the tribe Alebrini, by McAtee in 1926, included 2 genera and 26 species, 9 of which McAtee had not seen. The alebrine genera were treated by the present writer in 1952, but it was noted then that material was too limited to permit formulation of sound generic concepts and that some of the genera were heterogeneous. Although much more material has been available for the present study, the large number of species represented by only a few specimens suggests that additional collecting will bring many more species to light, and that the present classification ultimately will be considered as an early, preliminary one. Ninety-six species and subspecies in 25 genera are treated. The large number of genera in proportion to the number of species, when viewed in the light of knowledge of genera in other faunal regions in other cicadellid tribes, leads again to the conclusion that the forms studied are only a fragment of the complete fauna. However, the small proportion of species to genera is not likely to persist when more collecting is done, as illustrated by the fact that three of the five

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monobasic genera of my 1952 classification are now known to contain additional species.

The relationship of the tribe to higher taxonomic categories of leafhoppers is not clear. According to present evidence, the group belongs in the subfamily Typhlocybinae, but is not closely related to any of the other typhlocybine tribes. The interrelationships of genera within the tribe are not always clear. Such relationships as are evident are discussed in connection with the generic descriptions.

The genera are primarily Neotropical and southern Nearctic, except the genus *Alebra*, which is Holarctic. Paoli (1941) described the subgenus *Alebra* (*Afralebra*) from a single female from Italian Somaliland. The true position of this form must remain in doubt until males can be examined.

Very little is known of food plants in most genera. The known food plants represent diverse families, grasses as well as woody plants.

Tribal characters: The tribe Alebrini includes all species of the subfamily Typhlocybinae in which an appendix is present on the forewing, a characteristic not found in the other tribes. The following combination of characters also separates them from other tribes: the presence of ocelli, the occurrence of two vannal veins in the hind wing, the presence of sternal abdominal apodemes in the male, and in the ninth tergum of the male a dorsal preanal excision that is deeper than that usually found in the subfamily.

External anatomy: The shape of the head is variable, ranging from strongly produced before the eyes in *Lawsonellus* and *Protalebrella* to very slightly produced, with anterior and posterior margins parallel, as in *Alebra, Albera, Lareba* and *Rabela*. The proportions of the dorsal surface of the head, the crown, have been employed as distinguishing characters at specific and occasionally at generic level. These proportions [2] have been obtained by comparing the median length of the crown with its interocular width, i. e., the shortest distance between the inner margins of the eyes. The disc of the crown may be flat, convex, or concave. Ocelli are present in all species, located almost always on the rounded margin between the crown and the face, and usually equidistant from inner eye margin and median line of head. The face is usually slightly convex in profile and divergent from the profile of the dorsum. No species were found with the contour of the face parallel to that of the crown, a condition that occasionally occurs in the Dikraneurini.

The pronotum is narrowest anteriorly, its lateral margins diverging posteriorly to a variable degree. The humeral margins are convex, and the posterior margin is usually shallowly concave, broadly exposing the scutellum. Measurements of the pronotum used in this

[2] Unless otherwise specified, all proportions in the descriptive portion of this paper apply to males.

paper refer to its length at the midline and its greatest width. The length of the pronotum exhibits more individual variation than the length of the crown. In most Alebrini the pronotum is longer than the crown and wider than the head including the eyes.

The forewing has an appendix which may extend to or around the apical wing margin. The apical wing margin is usually smoothly convex, but it may be obliquely truncate (*Protalebrella*). The venation varies greatly in the tribe, in minor respects among specimens of a species, and even between wings of a single specimen. The longitudinal veins are obscure in the middle portion of the wing, but distinct anteapically and apically. Usually veins R, M, and Cu extend directly to the bases of the apical cells, but rarely there are supernumerary cross veins, and occasionally some coalescence of the longitudinal veins anteapically (e. g., *Aphanalebra*, *Rabela*). The apical cells are four and are numbered beginning with the innermost with the wing in repose, but because this system of numbering is new to many users, the terms "inner" and "outer" are frequently substituted in the discussions which follow. There is much variation in their form. Most often the inner apical cell is broader basally than at its apex, the second apical cell is slender and parallel-sided, the third apical cell is triangular and often stalked, and the outer apical cell is short, not attaining the apical wing margin, and with its base proximad of the base of the third apical cell, but many departures occur from this commonest condition. In the corium the cell adjoining the claval suture is referred to as the brachial cell. In the middle third of the corium near the costal margin there usually occurs a waxy oval area, which is referred to as the costal plaque. The contiguous wing margins, when the wings are in the position of repose, are the commissural margins.

The hind wings have three longitudinal, one oblique, and three transverse veins. The longitudinal veins, beginning with the one nearest the costa, are R, M, and Cu. In the apical region, a continuation of vein R attains the apical wing margin, occasionally after becoming confluent with the anterior branch of vein M for a short distance. This apical portion of vein R, for convenience, has been termed the "posterior branch of vein R." It is usually connected with the anterior branch of vein M by a short cross vein which varies so much in postion that it has little taxonomic importance. In some species the posterior branch of vein R is evanescent apically, and in some it is confluent with the anterior margin of the wing before the wing apex.

The next more posterior apical vein of the hind wing is believed to be M_{1+2}, and the third is M_{3+4}. The hindmost vein in the apical series is Cu_1 which Evans (1946, p. 55) states is unbranched. This

vein is connected to vein M_{3+4} by a cross vein (m-cu) that often appears oblique or even longitudinal.

The oblique vein is Cu_2. The location of its apex has some taxonomic value. Most frequently the apex occurs at a point basad of the m-cu cross vein, but occasionally it occurs at a point opposite that cross vein.

The transverse veins of the hind wing are the first and second vannal veins, lying between the vannal and jugal folds, and a jugal vein in the jugum.

In the males of all the species examined, there is a pair of sternal intra-abdominal apodemes arising near the base of the abdomen and extending caudad into the abdominal cavity. Actually these have been shown to arise from abdominal sternum II, but the origin is not apparent without careful study and is of little importance for descriptive purposes. The length of the apodemes is useful to some extent. They may be vestigial or very prominent, and in the genus *Balera* they may be capitate apically. Their length is shown roughly in the descriptions and illustrations by indicating how many of the abdominal conjunctivae POSTERIOR TO THEIR ORIGIN they traverse. Thus, if the description states that the apodemes "attain the second conjunctiva," the words "posterior to their origin" are implied in each case to make the description correct morphologically. This is, of course, a rough measurement because the macerated abdomen is elastic, but even considering the variation in the length of the apodemes themselves, it permits useful comparisons.

The last visible sternum of the female is the seventh, and the shape of its hind margin is of taxonomic importance. On each side of the ovipositor, on the pygofer, there is a group of setae, usually irregularly spaced, and usually pale in color.

The tergum of the ninth segment of the male is termed the PYGOFER which, together with the ninth sternum and its lobe-like posteriorly-projecting male plates forms the genital capsule. The genital capsule is closed posteriorly by the intersegmental membrane between segments IX and X, the latter being the first segment of the anal tube. The sclerotized dorsal portion of the pygofer appears excised in macerated specimens, the excision representing the dorsal portion of the conjunctiva between segments IX and X. The excision is deeper in the Alebrini than is usually the case in other typhlocybine leafhoppers. The basal transverse sclerotized area before the excision may be an uninterrupted band, more heavily sclerotized or not, extending between and continuous with the lateral portions of the pygofer, or it may be separated from the larger lateral area of the pygofer by a weakly sclerotized line of flection laterally, or occasionally by internal heavily sclerotized bars, in the last two instances forming a

distinct ninth tergite. Along the dorsal excision, on each side, the integument is frequently thicker, and often there is a ventral extension of this thickened area, forming a dorsal pygofer process. Other pygofer processes may arise from the apical margin, the ventral margin, or on the disc. They are occasionally only differentially sclerotized areas of the pygofer wall, and tenuous, hence not very reliable as taxonomic characters, but often they are strong, sharply differentiated structures, frequently projecting away from the pygofer wall, and are then much less variable. The chaetotaxy of the lateral areas of the pygofer exhibits only slight variation, and has been found to be a useful character. The location of the very minute setae, termed "microsetae" in my 1952 paper, is not utilized in the present classification. The "macrosetae" are those conventionally termed "setae" in leafhopper taxonomy. They are easily observed with low magnification. Only in the genus *Alebra* are there setae of somewhat intermediate size. The macrosetae are usually few and in a characteristic location on the pygofer. Less commonly they are fairly numerous and are generally distributed over the pygofer disc but even then the pygofer is never heavily setose as is often the case in the subfamily Deltocephalinae.

The so-called "internal male genitalia" consist of the styles, the connective, and the aedeagus. The styles are more intimately connected with the plates in the Alebrini than is the condition in most leafhopper tribes, rendering dissection more difficult. They may be long or short, and there is occasionally a preapical lobe which is, however, usually less pronounced than that found in the Dikraneurini, Zyginini (*Zygina* and its relatives), or Erythroneurini. When a preapical lobe is present, that portion of the style from its cephalic end to the apex of the lobe is termed the SHANK.

The connective may be entirely (*Paralebra, Trypanalebra,* et al.) or partially (*Protalebra,* sensu stricto) membranous, or it may be entirely sclerotized (most genera). The aedeagus varies greatly among genera and occasionally even among species of a single genus. The basal opening, the atrium, which admits the gonoduct, may be at the base of the aedeagus or it may be more distal in position, in which case the more basal portion of the aedeagus is termed the PREATRIUM. There is usually a sclerotized area above the atrium, the DORSAL APODEME, to which muscles are attached, but this may be inconspicuous. Occasionally it is paired, and rarely it is asymmetrical. Its form is often useful in classification. The term SHAFT is applied to that portion of the aedeagus that bears the gonoduct. The shaft differs greatly in form in different species. There are also aedeagal processes of various sorts. These are called preatrial, atrial, or shaft processes, according to their point of origin.

In all of the measurements giving total length, the measurements were taken from the tip of the crown to the apex of the forewings in repose.

ACKNOWLEDGMENTS: The majority of the specimens examined in this work are in the United States National Museum collection. I am greatly indebted to the following for the privilege of examining material from the sources indicated: Dr. R. H. Beamer, Snow Entomological Collections, University of Kansas; Dr. B. P. Beirne, Canadian National Collection; Dr. D. M. DeLong, personal collection; Dr. J. N. Knull, the Ohio State University collection; Dr. C. E. Pemberton, Hawaiian Sugar Planters Association; Dr. E. S. Ross, California Academy of Sciences collection; Dr. George Wallace, Carnegie Museum; Dr. A. Willink, Fundación Miguel Lillo, Tucumán, Argentina.

Key to genera of Alebrini [3]

1. Forewing with appendix extending around wing apex *and* hind wing with submarginal vein distinct from apical wing margin 2
   Forewing with appendix not extending around apical wing margin, or if so (*Diceratalebra interrogata* (Knull)) then hind wing with submarginal vein confluent with apical wing margin 3
2. Hind wing with submarginal vein continuous apically with posterior branch of vein R; male plates with an apical lobe bearing a tuft of setae (distribution Holarctic) . . . . **Alebra** Fieber (p. 134)
   Hind wings with submarginal vein extending beyond posterior branch of vein R, and curved basad along costal margin (distribution Neotropical). **Orsalebra** Young (p. 141)
3. Male with anal tube having lateral paired and median unpaired processes. **Albera,** new genus (p. 143)
   Male occasionally with lateral paired anal processes, never with unpaired median process 4
4. Male with connective entirely membranous 5
   Male with connective, at least partly, heavily sclerotized 9
5. Male without an unpaired aedeagal process; paired aedeagal processes present . . . . **Paralebra** McAtee (p. 145)
   Male with an unpaired aedeagal process; paired processes present or absent . 6
6. Male with aedeagus symmetrical 7
   Male with aedeagus markedly asymmetrical 8
7. Crown of head with median length more than one-half interocular width and more than one-third median length of pronotum; male usually with paired aedeagal processes . . . . **Trypanalebra** Young (p. 153)
   Crown of head with median length less than one-half interocular width and less than one-third median length of pronotum; male without paired aedeagal processes . . . . **Blarea,** new genus (p. 159)

[3] The genus *Hadralebra* Young (Univ. Kansas Sci. Bull. vol. 35, p. 19, 1952) was erected for *Dikraneura* (*Hyloidea*) *laticeps* (Osborn) (Ann. Carnegie Mus. vol. 18, p. 277, 1928), although the genitalia are unique among typhlocybine leafhoppers, as was stated in the original generic description. A subsequent study of the genitalia of a number of neotropical Tettigellinae has revealed that *Hadralebra* is closely related to some tettigelline genera, and the study of specimens with entire wings will probably eventually confirm the correctness of its transfer to the Tettigellinae, made at this time.

8. Male with paired aedeagal processes; aedeagal shaft not recurved apically; forewing without confluent longitudinal veins before apical cells.
Relaba, new genus (p. 161)
Male without paired aedeagal processes; shaft recurved apically; forewing with veins M and Cu confluent proximad of the apical cells.
Aphanalebra McAtee (p. 163)
9. Aedeagus with two pairs of ventral processes arising at atrium.
Osbornulus, new genus (p. 164)
Aedeagus not so 10
10. Aedeagus drastically asymmetrical . . . . **Protalebra** Baker (p. 166)
Aedeagus not so 11
11. Style apex strongly sigmoid in lateral aspect; sternal abdominal apodemes elongate, slender, capitate, traversing at least two abdominal conjunctivae.
Balera Young (p. 171)
Style apex not strongly sigmoid in lateral aspect; sternal abdominal apodemes rarely (*Rhabdotalebra*) traversing more than one abdominal conjunctiva, not slender or capitate 12
12. Style in lateral aspect with a basal lobe extending beneath adjoining arm of connective (fig. 14,*c*); aedeagus with widely-separated short paired dorsal apodemes (fig. 14,*d*); head broadly rounded, only very slightly longer at middle than next to eye . . . . **Brunerella** Young (p. 176)
Not with above combination of characters 13
13. Crown with interocular width one-half greater than median length; forewing with outer apical cell broader than long; style greatly elongate.
Lareba, new genus (p. 180)
Without the above combination of characters; rarely with any one of above characters 14
14. Crown with median length more than twice interocular width; connective T-shaped with unpaired portion directed cephalad.
Lawsonellus, new genus (p. 182)
Crown with median length less than twice interocular width; connective not as above 15
15. Forewing with base of outer apical cell only slightly basad of base of third apical cell, the bases almost in same straight line which is at right angles to the long axis of the wing (fig. 17,*c*) . . . . . **Habralebra** Young (p. 183)
Forewing with base of outer apical cell, at least at its intersection with costal margin, distinctly basad of base of third apical cell 16
16. Color patterns of forewings including a conspicuous trans-commissural omega-shaped marking over the wings in repose (exception *lenticula* (Osborn)) . . . . **Omegalebra,** new genus (p. 199)
Forewings without omega-shaped marking 17
17. Male pygofer notched at apex (fig. 24,*g*); aedeagus with unpaired ventral process arising at base of shaft, exceeding shaft in length (fig. 24,*f*).
Erabla, new genus (p. 212)
Without above combination of characters 18
18. Aedeagal shaft semicircular or nearly so in lateral aspect; style with apical extension broadened at extremity . . . . **Rabela** Young (p. 214)
Not as above 19
19. Aedeagus with dorsal apodeme transverse, distinctly bilobed at apex; pygofer processes absent (exception: *sarana*); anal processes present (figs. 26, 27).
Elabra Young (p. 218)
Aedeagus with dorsal apodeme longitudinal, not lobed, or weakly lobed at base, or absent; anal processes present or absent 20

20. Style with preapical lobe usually very well developed; aedeagus with dorsal apodeme usually saddle-shaped in lateral aspect and bilobed at cephalic extremity; male pygofer with macrosetae nearly always restricted to posterodorsal portion (figs. 28–30) . . . **Rhabdotalebra** Young (p. 226)
    Not so 21
21. Aedeagus with dorsal apodeme distinct, often elongate 22
    Aedeagus without dorsal apodeme . . . . . . **Abrela,** new genus (p. 240)
22. Length of male more than 4 mm.; color pattern including a prominent zigzag vitta of red or black on each forewing; anal processes extending anteroventrad almost to ventral pygofer margin; ninth tergum with tergite delimited caudally and laterally by an integumental thickening.
    Beamerulus, new genus (p. 242)
    Length of male less than 4 mm.; color pattern not as above; anal process absent or very short, at most not extending beyond middle of pygofer; ninth tergite usually absent, occasionally delimited laterally but not caudally as described above 23
23. Aedeagus bifurcate apically (fig. 33,*e*) . . . **Diceratalebra** Young (p. 247)
    Aedeagus not so 24
24. Apex of forewing obliquely truncate or emarginate; anal tube without processes; color never including oblique angular red or orange markings.
    Protalebrella Young (p. 255)
    Apex of forewing rounded; anal tube with short processes; color pattern often including prominent oblique red or orange vittae.
    Barela, new genus (p. 264)

Genus *Alebra* Fieber

Figure 1

Compsus Fieber (*nec* Schoenherr, 1823), Verh. Zool.-Bot. Ges. Wien, vol. 16, p. 507, 1866.

Alebra Fieber, Katalog der Europäischen Cicadinen, p. 14, 1874 (nomen novum for *Compsus* Fieber).

Type of the genus *Cicada albostriella* Fallén by subsequent designation of Oshanin (Kat. Pal. Hemip., p. 111, 1912).

Hind wing with submarginal vein distinct and separate from apical margin, extending around apex and confluent with apex of posterior branch of vein R which is entire; vein Cu_2 confluent with submarginal vein at point opposite m-cu. Forewing with appendix extending around wing apex which is smoothly rounded; inner apical cell slender, not greatly wider in basal third than in apical half; about as long as second and third apical cells which are slender and parallel-sided; outer apical cell elongate triangular, with base slightly proximad of base of third apical cell, occasionally obsolescent. Female seventh sternum broadly produced posteriorly with apex shallowly emarginate. Male plates greatly exceeding posterior pygofer margin, lobed apically, each with a row of weak macrosetae along mesal margin and a cluster of dorsal macrosetae on the apical lobe. Pygofer with posterior margin produced in a dorsal and a ventral lobe; disc without macrosetae (occasionally with elongate fine microsetae along dorsal margin

of ventral lobe); pygofer process an inrolled portion of ventral pygofer margin. Ninth tergum with a differentially sclerotized transverse bar, without a tergite. Anal processes absent. Style elongate, without strong preapical lobe, apex decurved, acute. Connective triangular or V-shaped. Aedeagus with preatrium distinct; dorsal apodeme well-developed, slender and slightly compressed laterally, or membranous; shaft simple, slightly curved dorsad, without processes; gonopore apical. Sternal abdominal apodemes short, not traversing first conjunctiva. Head very weakly produced; crown with median length approximately two-thirds interocular width; ocelli on broadly rounded margin between crown and face, closer to median line than to inner eye margins. Pronotum at least twice median length of crown, wider than head including eyes; lateral margins strongly divergent posteriorly. Face slightly convex in lateral aspect.

Distribution is Holarctic.

The complete appendix of the forewing, the lack of macrosetae on the male pygofer and the apically lobed male plates with clustered setae on the lobes set *Alebra* well apart from other alebrine genera.

In addition to the species treated below, W. Wagner has described *Alebra sorbi* (Zentralbl. Ges. Forstw., vol. 3, p. 43, 1949), which I have been unable to examine. The species is closely related to *A. albostriella* (Fallén).

Key to species of *Alebra*

1. Pygofer, in lateral aspect, with posterior margin vertical in upper half, not notched . . . . **albostriella** (Fallén)
   Pygofer, in lateral aspect, with posterior margin strongly or weakly notched in upper half 2
2. Pygofer with posterodorsal margin strongly notched (fig. 1,*g*); connective strong, elongate-triangular; style expanded anteapically . . **aurea** (Walsh)
   Pygofer with posterodorsal margin weakly notched (fig. 1,*k*), connective weak, shallowly V-shaped; style gradually tapering . . . . . **fumida** Gillette

Alebra albostriella (Fallén)

FIGURE 1,*a–c*

Cicada albo-striella Fallén, Hemiptera Sveciae vol. 2, p. 54, 1826.
Cicadula elegentula Zetterstedt, Fauna insectorum Lapponica, vol. 1, p. 536, 1828.
Typhlocyba discicollis Herrich-Schaeffer, Deutschlands Insecten, Heft 124, p. 8, 1834.
Eupteryx fasciata Curtis, Brit. Ent., vol. 14, pl. 640, 1837.
Typhlocyba fulveola Herrich-Schaeffer, Deutschlands Insecten, Heft 164, p. 16, 1838.
Typhlocyba wahlbergi Boheman, Handl. Svenska Vet. Akad. (1845), p. 42, 1845.
Typhlocyba eximia Hardy, Trans. Tyneside Nat. Club, vol. 1, p. 417, 1850.
Alebra albostriella var. *viridis* Rey, Échange, vol. 10, p. 46, 1894.
Alebra flavocephala Kupka, Ent. Nachr., vol. 25, p. 33, 1899.
Alebra albostriella var. *albostriella* McAtee (in part?), Journ. New York Ent. Soc., vol. 34, p. 144, 1926.

Alebra albostriella var. *insigita* McAtee, Journ. New York Ent. Soc., vol. 34, p. 143, 1926.
Alebra albostriella var. *insignita* McAtee, Journ. New York Ent. Soc., vol. 34, p. 144, 1926.
(?) *Alebra albostriella* f. *costatella* Matsumura, Ins. Mats., vol. 6, p. 67, 1931.
Alebra albostriella var. *diluta* Ribaut, Faune de France, vol. 31, p. 196, 1936.
Alebra albostriella var. *dufouri* Ribaut, Faune de France, vol. 31, p. 197, 1936.
Alebra wahlbergi var. *brunnea* Ribaut, Faune de France, vol. 31, p. 198, 1936.
Alebra wahlbergi var. *pallescens* Ribaut, Faune de France, vol. 31, p. 198, 1936.
Alebra albostriella (part.) of American authors, nec Fallén.

Length of male 3.2–3.9 mm., of female 3.5–4.5 mm. Crown short, broad, anterior and posterior margins parallel. Male pygofer in lateral aspect with posterior margin vertical in upper half, the posterodorsal portion not, or only very slightly produced posteriorly, posterior margin in lower half produced posteriorly in a digitiform lobe, and appearing to have a tapered differentially-sclerotized process (actually merely the inrolled ventral pygofer margin). Style elongate, slender, abruptly decurved apically, in broadest aspect slightly expanded basad of the decurved portion, but without a distinct preapical lobe. Connective elongate-triangular. Aedeagus slender and elongate, preatrium short, dorsal apodeme elongate, slender, subcylindrical except expanded portion near union with shaft; shaft elongate, slender, gradually tapering, without processes, slightly bisinuate, the apex slightly procurved, shaft slightly asymmetrical in ventral aspect. Abdominal sterna of male bearing microsetae.

Color dimorphic. Male: Dorsum unmarked lemon yellow except apical cells and apices of anteapical cells which are hyaline; venter varying from entirely lemon yellow (occasionally with somewhat paler areas but these not constant) to black over thorax and abdomen. Female: Extremely variable. Typical variety with ground color of head, pronotum, and scutellum milky subhyaline to milky opaque, a pair of broad vittae beginning on posterior margin of crown next inner ocular margins and diverging over disc of pronotum to its hind margin, a broad vitta bordering the commissural margin from pronotum to apex of clavus, a broad vitta in corium beginning opposite apex of scutellum, extending parallel to claval suture almost to crossveins, and a broad vitta along anterior wing margin from base to apical cells, pale yellow to red, venter varying from pale yellow to black. Variety *discicollis* (Herrich-Schaeffer) with ground color of crown and pronotum sordid white, a broad median dark vitta beginning on disc of crown and extending with divergent lateral margins over pronotal disc and over entire scutellum, the last with transverse sulcus and a short narrow marking along each lateral margin jet black; forewing subhyaline usually with some indication of the longitudinal vittae of the typical variety, with a variable transverse broad stripe

near midlength of wing; face and venter entirely pale. Variety *diluta* Ribaut differing from typical form in forewing coloration in that commissural vitta is wanting, as is the subcostal vitta occasionally;

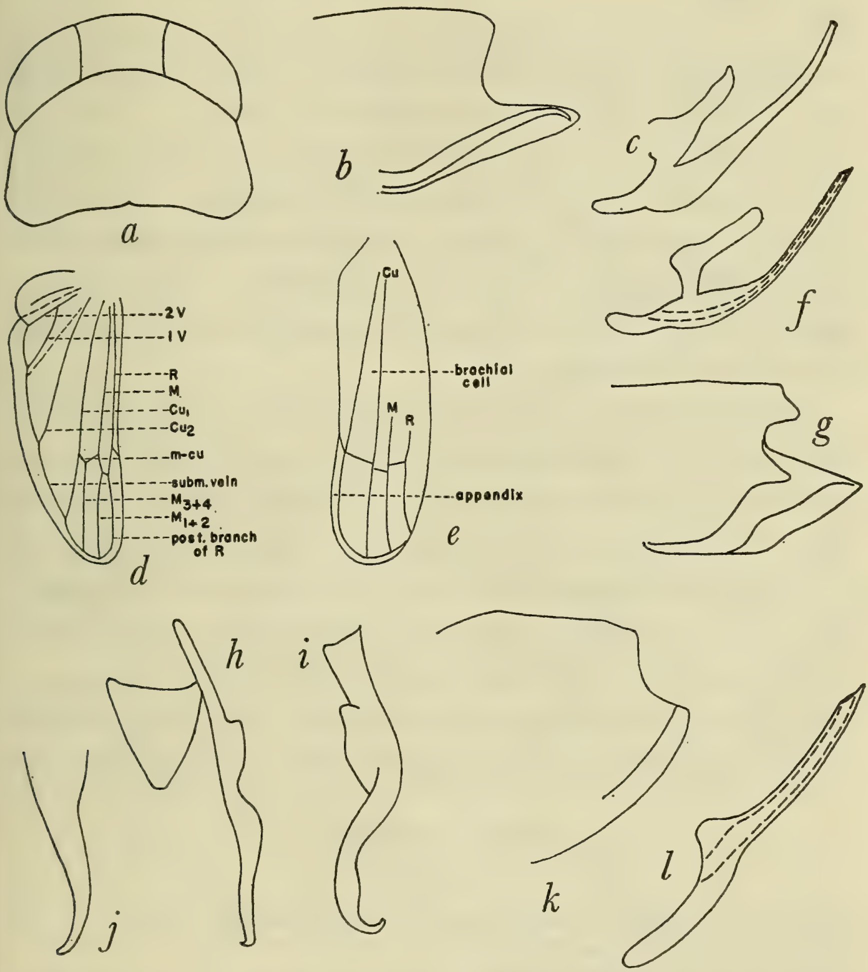

FIGURE 1.—*Alebra. a–c, A. albostriella: a*, anterior dorsum; *b*, pygofer, lateral aspect; *c*, aedeagus, lateral aspect. *d–i, A. aurea: d*, hind wing; e, forewing; *f*, aedeagus, lateral aspect; *g*, pygofer, lateral aspect; *h*, style and connective, ventral aspect; *i*, style, lateral aspect. *j–l, A. fumida: j*, style, apical portion, lateral aspect; *k*, pygofer, lateral aspect; *l*, aedeagus, lateral aspect.

all vittae yellow (based on original description). Variety *viridis* Rey (according to Ribaut's 1936 description) differs from the typical variety in that the white band of the clavus is narrower, and with its outer margin parallel to claval suture. to which it extends in some speci-

mens. In the original description, Rey merely stated that the stripes were green instead of yellow or orange. Variety *dufouri* Ribaut was described originally from two females which were dark brown from crown to apical half of forewings, except the basal angles of the pronotum.

The type of *A. albostriella* var. *insignita* McAtee (in USNM) has been examined. It agrees well with descriptions of the typical variety given by Ribaut (1936) and Ossiannilsson (1946, 106).

Ribaut (1936, p. 197) distinguishes a second European species, without genital characters, as *wahlbergi* (Boheman, 1845), but specimens studied from Zircz, Hungary, from Rijswijck, Holland, and Bucharest, Rumania appear to be intermediate in character, and it seems advisable to relegate *wahlbergi* (Boheman) to synonymy in view of this.

The original description states that both sexes are striped, but no males have been found to be marked like females of the typical variety in the course of this study.

American authors for many years have identified the common widespread North American species as *albostriella*, and the author followed this course in a recent publication (Young, 1952, p. 30), although constant differences in male genitalia were noted. Further study has led to the conclusion that the common North American species is distinct (see *Alebra aurea* (Walsh), below). The true *albostriella* has been taken in Washington, D. C., by Dr. E. D. Ball and Dr. O. Heidemann, and in the Arnold Arboretum, Boston, Mass., by Dr. Harold Morrison. Possibly the species has been introduced.

Ribaut (1936, pp. 195, 197) lists oak, elm, birch, alder, maple, linden, walnut and hawthorn as food plants. One of the specimens taken in Washington, D. C., was taken from hickory. The single specimen from the Arnold Arboretum was swept from *Physocarpus* sp.

***Alebra aurea* (Walsh)**

FIGURE 1,*d–i*

Typhlocyba aurea Walsh, Prairie Farmer, vol. 10, new ser., p. 149, 1862.
Typhlocyba binotata Walsh, loc. cit.
Typhlocyba pallidula Walsh, loc. cit.
Typhlocyba aurata Gillette, Proc. U. S. Nat. Mus., vol. 20, p. 713, 1898. [err. pro *aurea* Walsh], new synonymy.
Alebra albostriella var. *rubrafrons* DeLong, Ohio Journ. Sci., vol. 18, p. 240, 1918, new synonymy.
Alebra bicincta DeLong, loc. cit., new synonymy.
?*Alebra eburnea* DeLong, op. cit., p. 241, new synonymy.
Alebra albostriella var. *tincta* McAtee, Journ. New York Ent. Soc., vol. 34, p. 143, 1926, new synonymy.
Alebra albostriella var. *agresta* McAtee, op. cit., p. 144, new synonymy.
?*Alebra albostriella* var. *albostriella;* McAtee (in part), loc. cit., new synonymy.
Alebra albostriella var. *fulveola;* McAtee, loc. cit., new synonymy.

Alebra albostriella var. *scopa* McAtee, op. cit., p. 145, new synonymy.
Alebra albostriella var. *discicollis;* McAtee, op. cit., p. 146, new synonymy.
Alebra albostriella; American authors nec Fallén, new synonymy.

Length of male 3.3–4.2 mm., of female 3.7–4.4 mm. Male pygofer, in lateral aspect with posterodorsal portion produced posteriorly forming a short dorsal lobe, forming with the more ventral longer lobe, a distinct notch. Aedeagus in lateral aspect with shaft smoothly curved, not bisinuate. Other characters as in *A. albostriella* (Fallén).

Color variable. MALE: Typical variety as described above for *Alebra albostriella* (Fallén), but with the yellow color of the forewings frequently entirely filling the anteapical cells and occasionally tinted with orange. Variety *rubrafrons* DeLong with coloration like typical variety but with crown, clypeus and clypellus pink to red. In variety *pallidula* Walsh (sens. McAtee), markings are chiefly lacking, with the forewing apices occasionally fumose (the original description also included specimens with pale yellow vittae on commissural and costal margins). In the holotype of var. *tincta* (McAtee) the apex of the forewing from slightly in front of cross veins to wing apex is covered by a transverse smoky band. The pygofer is as described above. FEMALE: Variety *pallidula* (Walsh) with coloration as discussed under the male variety of this (above). Variety *binotata* (Walsh) with two transverse dark submarginal spots near anterior margin of pronotum. Variety *bicincta* DeLong with two broad transverse dark bands on forewings, the anterior one beginning opposite apex of scutellum and extending to midlength of commissural margin of clavus, the posterior one from apices of anteapical cells to wing apex. Variety *agresta* McAtee with a pale yellow vitta along anterior margin, fading out near midlength of wing, and a second similarly colored vitta along commissural margin to cross veins; pronotum occasionally with a broad median pale yellow vitta.

This species is undoubtedly more widespread than the collections at hand indicate. Specimens have been examined from Ontario, Massachusetts, New York, Maryland, District of Columbia, Virginia, Kentucky, Wisconsin, Missouri, and Kansas. Tennessee should be added to the list because it has the type localities for some of DeLong's varieties.

Specimens have been collected from maple, linden, oak, chestnut, sycamore, dogwood, and elm. The species was abundant on the campus of the University of Louisville in a group of elms, many of which were dying from phloem necrosis.

Some of the specimens placed in var. *pallidula* Walsh by McAtee are teneral. DeLong's *eburnea* was placed in synonymy with *pallidula* Walsh by McAtee (1926, p. 143) and from the original description that disposition appears correct. The type of *eburnea* had darker

longitudinal lines on the pronotum, however, according to the original description.

Variety *agresta* McAtee appears to represent the commonest coloration of the female. McAtee's paratype series of this variety contains a number of females and two males, one of which is a monstrosity, the other a specimen with male genitalia like those described below for *Alebra fumida*, but containing a dorilaid parasite. It seems advisable, at present, to consider var. *agresta* McAtee to apply only to females.

The variety treated by McAtee (1926, pp. 143, 144) as var. *albostriella* probably does not occur in this species, although this cannot be certified until female specific characters have been found. Red-striped females are completely unknown in North America for any species in the genus.

The variety which McAtee (1926, pp. 143, 144) interpreted as var. *fulveola* (Herrich-Schaeffer) appears to be typical *aurea* (Walsh).

The type of *A. albostriella* var. *scopa* McAtee, a female, has been examined. It appears to be a poorly colored specimen, perhaps teneral, of this common North American species. The dark spot on the base of the scutellum does not appear well-defined, and probably is not integumental.

The variety McAtee assigned to var. *discicollis* (Herrich-Schaeffer) is represented, in the specimens examined, only by a good series of females from Washington, D. C., and from surburban Virginia. Oman collected a copulating pair on *Acer campestre*. The male has a pygofer typical for this species. The color variety does appear to be the analogue of *Alebra albostriella* var. *discicollis* (Herrich-Schaeffer). With the elevation of *aurea* to specific rank, this variety is left nameless. There seems to be no point in adding one more to an already overbundant group of varietal names.

The form McAtee treated as *fumida* Gillette is a good species, based upon an examination of the genitalia of Gillette's type. A pair of specimens taken by the writer in Louisville, Ky., had similar coloration, but the aedeagus of the male and the style apex is like typical *aurea*. The pygofer of the Kentucky specimen, unfortunately, has been lost. A series taken on *Crataegus* in Prince Edward County, Ontario, is colored as in *fumida*, but the male genitalia present only minor differences from *aurea* as interpreted here.

Alebra fumida Gillette

FIGURE 1, *j–l*

Alebra fumida Gillette, Proc. U. S. Nat. Mus. vol. 20, p. 714, 1898.
Alebra albostriella var. *fumida;* McAtee (part?), Journ. New York Ent. Soc., vol. 34, p. 145, 1926.

Length of male 3.2–4.2 mm., of female 3.6–4.2 mm. Male pygofer in lateral aspect with posterodorsal portion broadly, shallowly concave, both lobes on posterior pygofer margin markedly shorter than in *A. aurea* (Walsh). Styles not expanded anteapically as in *A. albostriella* (Fallén), gradually tapering to acute decurved apices. Connective shallowly V-shaped, style base not or only slightly extended cephalad from articulation with connective. Other characters as in *A. albostriella* (Fallén).

Variable, both sexes from entirely yellowish white to darker. Darker males either with crown yellow, pronotum and scutellum light gray, the latter with brown basal angles, forewings translucent with commissural margin, claval suture, and corial streak parallel to claval suture narrowly yellow, or (type) with crown sordid brown, pronotum and scutellum much darker brown, forewing except costal plaque entirely smoky translucent with the apical cells slightly darker. Darker females with crown pale yellow to brownish yellow, pronotum brownish yellow to pale brown, a lighter spot near midlength of each lateral margin, scutellum dark brown, forewing yellowish hyaline, claval region suffused with light brown, apical cells fumose.

Specimens are at hand from New York, Wisconsin, Kansas, Iowa, and Illinois (males from Wisconsin and New York).

This species, with distinct morphological characters, cannot be separated, on the basis of color alone, from *aurea* (q. v. for discussion of darker specimens from Kentucky and Canada).

Genus *Orsalebra* Young

FIGURE 2

Orsalebra Young, Univ. Kansas Sci. Bull. 35, p. 23, 1952 (type *Orsalebra robusta* Young by original designation).

Hind wing with submarginal vein extending around wing apex, distinct from apical margin, continued beyond apex of posterior branch of R along costal margin towards base of wing, becoming evanescent near midlength of costal margin; posterior branch of R entire apically; vein Cu_2 attaining submarginal vein at point opposite vein m-cu. Forewing with appendix extending around wing apex; bases of first, second, and third apical cells rectilinear, these cells successively shorter towards costal margin; outer apical cell open at base; first and second apical cells with lateral margins subparallel; third apical cell broader apically than at base. Female seventh sternum with hind margin produced, regularly convex. Male plates greatly exceeding posterior pygofer margin, broad basally, each plate abruptly narrowed in apical third, with apex broadly rounded; disc with multiseriate short macrosetae in basal two-thirds, becoming uniseriate in apical third and extending to apex. Pygofer with mid-

posterior margin produced and forming a subquadrate thickened short apical process; macrosetae multiseriate, submarginal near posterodorsal margin; pygofer wall with an oblique thickened integumental rod. Ninth tergum without a tergite or a differentially sclerotized area. Style elongate, with small distinct dorsal preapical lobe and short apical extension directed ventrad. Connective U-shaped, vertical. Aedeagus asymmetrical with preatrium elongate, dorsal apodeme well developed, more than half length of shaft, shaft with anteapical processes and processes near midlength. Sternal abdominal apodemes vestigial. Head with anterior margin broadly rounded, posterior margin parallel to anterior; ocelli on broadly rounded margin between crown and face, closer to median line of head than to eyes. Pronotum much longer than head, its width subequal to width of head including eyes, lateral margins short, strongly divergent posteriorly. Face flat in lateral aspect.

Known only from the genotype, from Ecuador. At present, *Orsalebra* is believed to be not closely related to other alebrine genera. The venation of the hind wing, with the submarginal vein extending beyond the apex of the posterior branch of vein R thence basad along the costal margin (this sector of the submarginal vein which probably represents the preservation of one of the more anterior branches of vein R, is unknown elsewhere in the Alebrini, and is suggestive of the Dikraneurini). The form of the head, enclosing a great portion of the anterior pronotal margin is also a unique feature in the tribe. In the hind wing the confluence of vein Cu_2 with the submarginal vein opposite vein m-cu is an unusual character, but it occurs also in *Alebra*, and the condition is approached in the genus *Trypanalebra*. The occurrence in the forewing of an appendix that extends around the wing apex is found elsewhere in the tribe only in *Alebra* and in *Diceratalebra interrogata* (Knull).

Orsalebra robusta Young

FIGURE 2

Orsalebra robusta Young, Univ. Kansas Sci. Bull. 35, p. 24, 1924.

Length of male 4.6 mm., of female 4.5 mm. Crown with median length less than half interocular width and about one-third median length of pronotum. Aedeagus with pair of once-branched processes slightly distad of midlength, each process bearing small projections and appearing somewhat pectinate; with three retrorse anteapical processes on cephalic surface near apex; apex a laterally compressed decurved lobe.

Ground color of dorsum yellowish white, a spot around each ocellus and basal angles of scutellum pale orange; three longitudinal vittae on pronotum, apex of scutellum and vitta within claval suture bright

orange. Forewing with vein Cu bright (holotype) or pale orange; claval apex and small portion of adjoining appendix deep black; brachial cell apically and apical cells, fumose. Face with suggestion of two yellow markings at base; remainder of venter stramineous except dark tarsal claws.

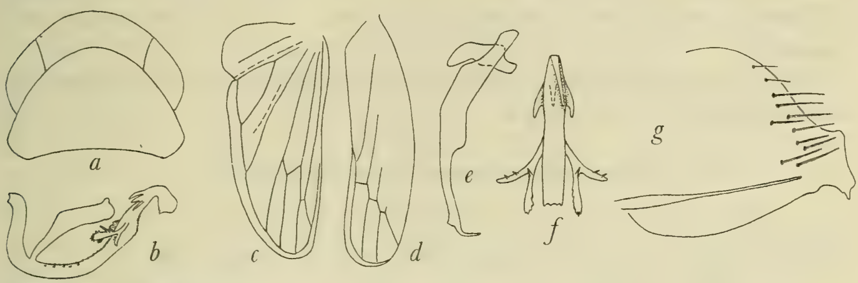

FIGURE 2.—*Orsalebra robusta: a*, anterior dorsum of female allotype; *b*, aedeagus, lateral aspect; *c*, hind wing; *d*, forewing; *e*, style and connective, lateral aspect; *f*, aedeagus, apex, caudal aspect; *g*, pygofer, lateral aspect.

This species is known only from the holotype and allotype, from Hacienda Talahua, Bolívar, Ecuador (F. M. and H. H. Brown), in the Snow Entromological Collections.

Albera, new genus

FIGURE 3

Type of the genus, *Protalebra picea* Osborn.

Hind wing with submarginal vein confluent with apical wing margin; posterior branch of vein R entire apically; vein Cu_2 confluent with submarginal vein at point basad of vein m-cu. Forewing with appendix not extending around apex; inner apical cell only slightly broader at base than in apical half; second apical cell slender, elongate, parallel-sided; third apical cell elongate, triangular; outer apical cell elongate, triangular, much longer than broad, not attaining apical wing margin, its base distinctly proximad of base of third apical cell. Male plates elongate, greatly exceeding posterior pygofer margin, each with a single row of macrosetae from near base to apex. Pygofer with posterior margin strongly produced, macrosetae in an anteapical vertical row; process arising at apex of pygofer. Ninth tergum without a tergite or heavily sclerotized area. Anal tube with unpaired median and paired lateral processes. Style elongate, slender, preapical lobe weak. Connective Y-shaped with the unpaired portion broad. Aedeagus with preatrium absent; dorsal apodeme saddle-shaped; shaft simple, without processes. Sternal abdominal apodemes traversing one conjunctiva. Head strongly produced, crown

with median length exceeding interocular width; ocelli on broad margin between crown and face, equidistant from inner eye margins and median line of head. Pronotum longer than head, wider than head including eyes; lateral margins weakly divergent posteriorly. Face convex in lateral aspect.

Known only from the genotype, from Brazil, Venezuela, and Panama.

The three anal processes serve to set this genus apart from all other known genera of Alebrini.

Albera picea (Osborn), new combination

Figure 3

Protalebra picea Osborn, Ann. Carnegie Mus. Vol. 18, p. 265, 1928.

Length of male 2.8 mm., of female 2.8–3.0 mm. Crown with anterior margin broadly rounded, disc convex; median length almost one-half greater than interocular width. Pronotum with median length less than twice median length of crown. Female seventh sternum subtriangular, sinuate on each side of a pronounced lobate

Figure 3.—*Albera picea: a*, anterior dorsum; *b*, aedeagus, lateral aspect; *c*, style and connective, dorsal aspect; *d*, style apex, lateral aspect; *e*, anal processes, lateral aspect; *f*, apex of forewing; *g*, apex of hind wing; *h*, pygofer, lateral aspect.

median posterior projection; pygofer with weak macrosetae near and parallel to ovipositor from near base to apex. Male pygofer with a weakly sclerotized apical process directed caudomesad, not attaining midline. Style with apical narrowed portion decurved; aedeagus with dorsal apodeme laterally compressed, narrower at base than at apex; shaft abruptly narrowed on ventral margin in basal third; gonopore near midlength of caudal margin. Anal tube with a pair of lateral decurved hooks and a large unpaired median lanceolate process, all heavily sclerotized.

Crown ivory suffused with tan, with a longitudinal black stripe on each side extending from near base of crown to an anteapical paler

ocellus-like spot spot for which it forms a border. Pronotum pitch-black. Scutellum dark brown, shining, the apical third ivory. Forewing translucent shining brown; clavus with basal triangular and apical trapezoidal transcommissural spots ivory, the latter extending slightly into the brachial cell of each wing, and a quadrate transcommissural spot behind middle, ivory anteriorly, hyaline posteriorly; corium with four translucent wedge-shaped spots along middle half of costal margin, the third suffused with ivory. Face stramineous, a narrow rim around ocelli, except laterally, and a triangular vitta extending ventrad and mesad from the anteroventral corner of each eye, black. Pleural portion of pronotum pitch-black; thoracic pleura dark brown. Hind leg with apex of femur and apical tarsomere dark brown; middle leg with apical tarsomere dark brown; foreleg variable, from unmarked yellow to yellow with a transverse marking on each femur, and entire tibia and tarsus, black. Remainder pale beneath except female pygofer and ovipositor which are pitch-black.

The type, a female from Fort Principe, Rio Guaporé, Brazil, is in the Carnegie Museum collection. Additional specimens have been examined from Aguadulce, Coclé Province, and Garachiné, Darién Province, Panama, and from Barinas, Venezuela.

This peculiar species has the facies of *Xestocephalus*, but appears properly placed in the Alebrini.

Genus *Paralebra* McAtee

Figures 4, 5

Protalebra subgenus *Paralebra* McAtee, Journ. New York Ent. Soc., vol. 34, pp. 147, 151, 1926 (type *Protalebra similis* Baker by original designation).

Protalebra subgenus *Plagalebra* McAtee, op. cit., pp. 147, 151 (type *Protalebra singularis* Baker by original designation).

Protalebra subgenus *Kallebra* McAtee, op. cit., p. 152 (type *Protalebra ninettae* Baker by original designation) new synonymy.

Paralebra; Young, Univ. Kansas Sci. Bull. 35, p. 28, 1952.

Kallebra; Young, op. cit., p. 22

Hind wing with submarginal vein confluent with apical wing margin; posterior branch of vein R evanescent or not apically; vein Cu_2 confluent with submarginal vein at point proximad of vein m-cu. Forewing with appendix not extending around apex which is smoothly rounded; inner apical cell usually broader at base than at apex; second apical cell parallel-sided; third apical cell stalked; outer apical cell variable in shape, short, not attaining apical wing margin. Male plates elongate, triangular, each with a longitudinal group of macrosetae parallel to lateral margin. Pygofer with posterior margin produced or truncate; macrosetae in vertical irregular row on disc; processes arising ventrally. Ninth tergum differentially sclerotized with or without lines of flection. Anal processes present or absent.

Style variable interspecifically, with or without preapical lobe. Connective membranous. Aedeagus with a pair of conspicuous processes arising near base; preatrium present or absent; dorsal apodeme distinct or greatly reduced. Sternal abdominal apodemes traversing first conjunctiva. Head moderately to strongly produced, crown with apex rounded or angular, median length equal to or exceeding interocular width; ocelli about equidistant from inner eye margins and median line of head. Pronotum with median length equal to or exceeding that of crown, as wide as or wider than head including eyes, lateral margins varying interspecifically from slightly to strongly divergent posteriorly. Face from slightly concave to strongly convex in lateral aspect.

Distribution: Mexico, Central and South America, and West Indies.

Paralebra can be separated from other genera in the group with a membranous connective in the male by its lack of an unpaired aedeagal process.

Key to species of *Paralebra*

1. Crown with conspicuous black spot at apex; forewing with inner apical cell not conspicuously broader at base than at apex; ocelli slightly above margin between crown and face. . . . . **ninettae** (Baker)
   Crown marked otherwise; forewing with inner apical cell much broader at base than at apex; ocelli slightly below margin between crown and face . . 2
2. Crown without a cruciate pale marking, median length about equal to interocular width; total length of insect less than 3 mm. 3
   Crown with a cruciate pale marking, median length one-third greater than interocular width; total length of insect 3 mm. or more 4
3. Aedeagus with atrial processes extending directly caudad; male pygofer with ventral process inconspicuous and not strongly curved apically. **similis** (Baker)
   Aedeagus with atrial processes appearing looped, extending dorsad thence caudad; male pygofer with ventral process conspicuous and strongly curved apically . . . . **keiferi,** new species
4. Male with ventral pygofer process conspicuous, hook-shaped; aedeagal shaft smoothly curved . . . . **decurvata,** new species
   Male with ventral pygofer process minute, not hooked; aedeagal shaft bisinuate . . . . **singularis** (Baker)

Paralebra similis (Baker)

FIGURE 4,*a–e*

Protalebra similis Baker, Psyche, vol. 8, supplement, p. 403, 1899.

Protalebra (*Paralebra*) *similis* McAtee, Journ. New York Ent. Soc., vol. 34, p. 151, 1926.

Paralebra similis; Young, Univ. Kansas Sci. Bull. 35, p. 29, 1952.

Length of male 2.6–2.8 (type) mm., of female 2.7 mm. Crown with median length equal to interocular width and slightly less than length of pronotum; disc flat; width of head including eyes equal to

width of pronotum or slightly less. Ocelli slightly below margin between crown and face. Pronotum with lateral margins slightly divergent posteriorly. Face almost flat in profile. Hind wing with posterior branch of vein R entire apically. Female seventh sternum with median keel, posterior margin rectilinear; pygofer with few dispersed pale macrosetae on apical half near ovipositor. Male plates exceeding posterior pygofer margin, each with a single row of macrosetae from near base almost to apex. Male pygofer truncate apically (not always obviously so in lateral aspect, but if not then distinctly so in ventrolateral aspect); ventral portion with a distinct lobe (resulting from inrolling of ventral margin) or not; ventral portion with a short inconspicuous process. Ninth tergum with a heavily sclerotized transverse bar, without distinct lines of flection laterally. Anal processes absent. Style elongate, slender, without preapical lobe, rounded at apex, apical portion slightly decurved. Aedeagus with preatrium short, slender; dorsal apodeme paired, the arms short, extending caudodorsad; atrium V-shaped in cephalic aspect, with a process arising dorsally on each side, expanded in apical half, thence gradually tapered to acute apex which exceeds apex of shaft; shaft arising dorsally in atrium, funnel-shaped, the basal half from broadly to slightly expanded on dorsal margin, a variable portion of apical half curved dorsad (extreme apex in type, considerably more in some other specimens examined); gonopore terminal.

Ground color of crown and pronotum dull orange, crown fading anteriorly to a narrow submarginal ivory area, posterior margin of pronotum olive, separated from disc by a sharp black line. Scutellum dull yellow, the transverse sulcus, a triangular spot at midlength of lateral margin, and apex, black. Forewing with ground color olive, an elongate inverted U-shaped marking in basal half of clavus connecting posteriorly with a broader oblique vitta extending from commissure posterolaterad over half width of corium, a longitudinal vitta in apical third of clavus, the claval suture narrowly in basal half, broadly in apical third, a broad submarginal streak parallel to anterior wing margin over basal two-thirds, interrupted by costal plaque, a dash at midlength of cell R, apical portions of cells R and M and apical cells except areoles in second and fourth apical cells, black; a longitudinal vitta at base in corium next claval suture, a diagonal vitta behind coextensive with and parallel to the black oblique claval vitta, an areole in apex of cell R, and one in outer apical cell and apical veins, white; second apical cell with a hyaline areole. Face black, a narrow transverse basal line, through ocelli, and apex of clypellus, ivory. Legs pale, middle tarsus with a single band, hind tarsus with two bands, a broad femoral and tibial band on each hind leg, black, remainer of venter black.

The type, in the U. S. National Museum, bears the label "Corumba" [Brazil] and "May." The original description stated that the specimen was collected in April. Specimens with no consistent morphological differences have been observed from Panama, British Honduras, Venezuela, Haiti, and the Dominican Republic. Puerto Rico should be added to this range, because Caldwell (1952) illustrated a male.

Paralebra keiferi, new species

FIGURE 4,*f–h*

Length as in *P. similis* (Baker). Crown with median length slightly exceeding interocular width and four-fifths median length of pronotum; disc flat; width of head including eyes slightly less than width of pronotum. Lateral margins of pronotum, ocelli, face, female pygofer and seventh sternum, and male plates as in *similis*. Male pygofer with posterior margin broadly rounded; pygofer processes arising ventrally, each with apex hooked dorsad in lateral aspect. Ninth tergum as in *similis*. Anal processes absent. Style similar to that of *similis*. Aedeagus with preatrium and dorsal apodemes absent, with a pair of dorsal atrial processes extending slightly cephalad at their bases, thence curved sharply caudad, each process aciculate; shaft slightly expanded on dorsal margin near midlength, much shorter and broader than in *similis*, apex curved dorsad; gonopore terminal.

Color similar to *similis* but with an additional transverse white streak on face extending between antennal bases, and with an additional transverse black stripe on disc of pronotum, not attaining lateral pronotal margins.

Holotype male, allotype female and long series of paratypes of both sexes, Socorro Island, in the Revilla Gigedo group, 2,000 ft., May 8, 1925 (H. H. Keifer), in California Academy of Sciences collection. Male and female paratypes in U. S. National Museum.

Paralebra ninettae (Baker), new combination

FIGURE 4,*i–l*

Protalebra ninettae Baker, Psyche, vol. 8, p. 403, 1899.
Protalebra (*Kallebra*) *ninettae;* McAtee, Journ. New York Ent. Soc., vol. 34, p. 152, 1926.
Kallebra ninettae; Young, Univ. Kansas Sci. Bull. 35, p. 23, 1952.

Length of male 2.8 mm. Crown with median length almost one-half greater than interocular width and about three-fourths of median length of pronotum; disc convex; width of head including eyes less than width of pronotum. Ocelli slightly above margin between crown and face. Pronotum with lateral margins strongly divergent posteriorly.

Face in profile, and posterior branch of vein R of hind wing as in *P. similis* (Baker). Male plates exceeding posterior pygofer margin, each with a single row of macrosetae in apical two-thirds. Male pygofer with posterior margin regularly convex; pygofer process arising on ventral margin, short, inconspicuous. Ninth tergum as in

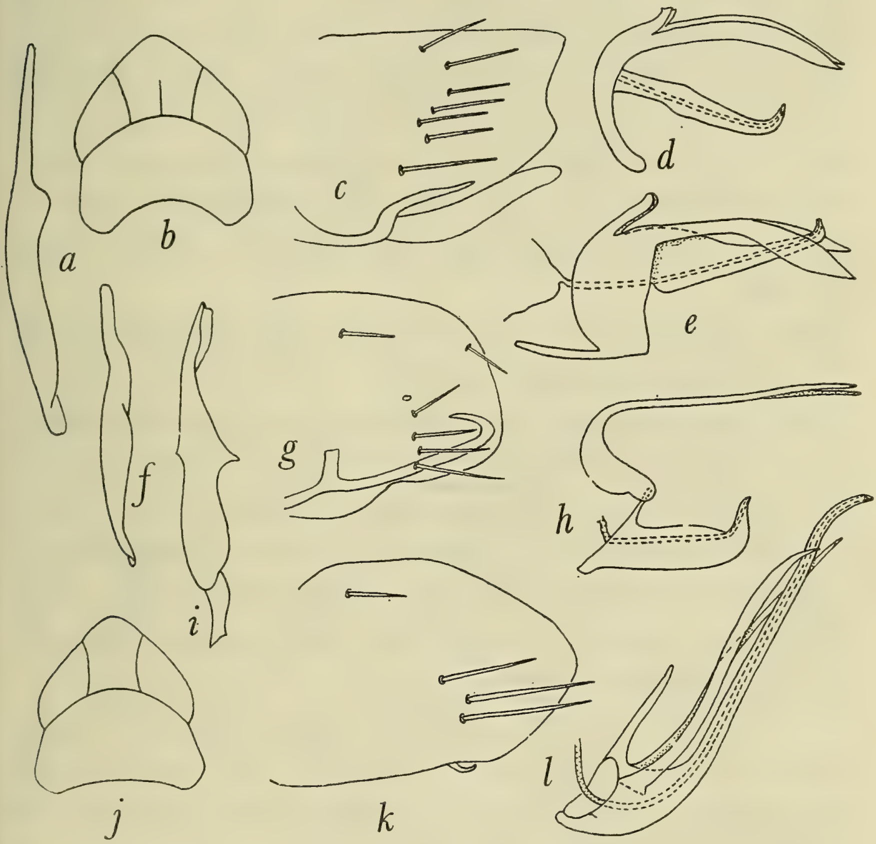

FIGURE 4.—*Paralebra.* *a–e, P. similis: a*, style, ventral aspect (type); *b*, anterior dorsum (type); *c*, pygofer, lateral aspect (type); *d*, aedeagus, lateral aspect (specimen from Garachine, Panama); *e*, aedeagus, lateral aspect (type). *f–h, P. keiferi: f*, style, ventral aspect; *g*, pygofer, lateral aspect; *h*, aedeagus, lateral aspect. *i–l, P. ninettae* (type): *i*, style, ventral aspect; *j*, anterior dorsum; *k*, pygofer, lateral aspect; *l*, aedeagus, lateral aspect.

similis. Anal processes absent. Style with preapical lobe, apical extension curved caudoventrad, the tip obliquely truncate in ventral aspect. Aedeagus with preatrium absent: dorsal apodeme well developed, unpaired, triangular in cephalic aspect; shaft elongate, slender, curved slightly caudad at apex with a pair of processes arising dorsally at base and extending to apical fifth of shaft, acute apically; gonopore terminal.

Crown white with a conspicuous apical black spot. Pronotum dark orange with an M-shaped black vitta on posterior half of disc, enclosing a more anterior V-shaped pale marking which in turn encloses a small black triangle situated in middle of disc. Scutellum with basal angles broadly orange, median line on basal half and extreme tip, black, anteapical portion broadly white. Basal half of clavus and adjoining corium striped with olive green and dark, a spot at base of corium, the costal plaque, a spot at apex of claval cell and a transverse dash from commissure through brachial cell, white, the last bordered anteriorly with dark; ground color of apical half of forewing smoky subhyaline, the veins olive green except those bordering outer apical cell which are dark. Face pale dorsally except a large spot beneath each ocellus, crimson in ventral half except narrow pale lateral margins of genae; basal antennal segment black. Legs pale yellow.

Known only from the type, a male from Chapada, Brazil, in the U. S. National Museum collection, and a male specimen from Río Tabasara, Chiriquí Province, Panama.

In my 1952 paper I stated that the style did not possess a preapical lobe. This was erroneous, for the lobe is distinct, but small. I erred also in stating that aedeagal processes arose from the dorsal apodeme. They arise from the base of the shaft near the dorsal apodeme. Third, with only the type at hand, I duplicated McAtee's erroneous observation that a cell of the forewing was absent in the apical series. More careful observation reveals a very small triangular third apical cell near the wing margin in the type. The third apical cell is very distinct in the Panama specimen.

Paralebra ninettae is easily separable from other species in the genus by external features as set forth in the key. The presence of the preapical lobe of the style is distinctive also, and the entire posterior branch of vein R in the hind wing will separate it from all other species of the genus except *similis*.

Paralebra singularis (Baker)

FIGURE 5,*a*,*b*

Protalebra singularis Baker, Psyche, vol. 8, supplement, p. 402, 1899.

Protalebra (*Plagalebra*) *singularis;* McAtee, Journ. New York Ent. Soc., vol. 34, p. 151, 1926.

Paralebra singularis; Young, Univ. Kansas Sci. Bull. 35, p. 29, 1952.

Length of both sexes, 3.8 mm. Crown with median length more than one-third greater than interocular width, and equal to length of pronotum; disc concave; width of head including eyes less than width of pronotum. Ocelli as in *P. similis* (Baker). Pronotum with lateral margins strongly divergent posteriorly. Face flat in profile. Forewing

with two discal cells delimited by supernumerary cross veins. Hind wing with posterior branch of vein R evanescent apically. Female seventh sternum very slightly produced posteriorly at middle, the apex obtusely angulate. Male plates not attaining posterior pygofer margin, each with a single row of macrosetae on middle half. Male pygofer produced and regularly convex apically; ventral pygofer process inconspicuous, short; dorsal process arising in basal half of dorsal margin, extending ventrad beyond middle of pygofer disc. Ninth tergum as in *similis* but with distinct lines of flection laterally.

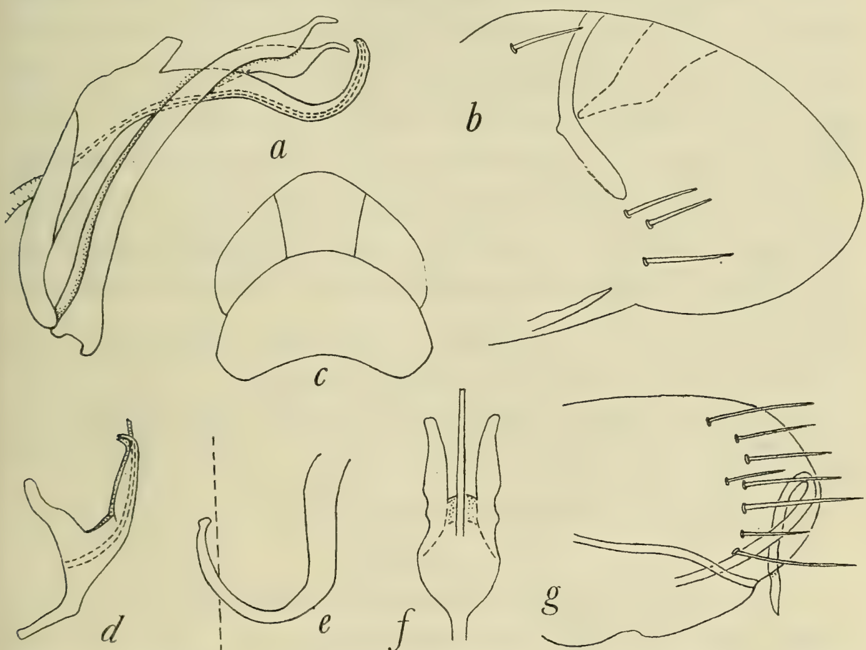

FIGURE 5.—*Paralebra. a–b, P. singularis: a*, aedeagus, lateral aspect; *b*, pygofer, lateral aspect (broken line represents anal process). *c–g, P. decurvata: c*, anterior dorsum; *d*, aedeagus, lateral aspect; *e*, pygofer process, caudal aspect (median line broken); *f*, aedeagus, ventral aspect; *g*, pygofer, lateral aspect.

Anal processes distinct, short, triangular. Style elongate, slender, with ventral preapical lobe, apex slightly decurved. Aedeagus with preatrium absent; atrium omega-shaped in cephalic aspect, the closed dorsal portion forming the dorsal apodeme, with a process arising at base on each side, extending caudodorsad in a gentle arch, as long as shaft, bisinuate and narrowed at apex with tip decurved; shaft funnel-shaped, bisinuate, the apex directed dorsad; gonopore terminal.

Crown with ground color dark orange with a dull ivory cruciate

marking, the cross-piece attaining the lateral margins just anterior to eyes. Pronotum as in *similis* but with a node at middle of transverse black marking. Scutellum orange to yellow, a spot along each lateral margin opposite end of transverse sulcus, and apex of scutellum, black. Forewing with entire clavus and basal half of corium except two large paler spots near base of latter, orange mottled with small paler spots, an arcuate vitta beginning at midlength of commissural margin of clavus and extending caudolaterad, broadened apically and ending on costal margin, translucent gray, the broadened apical portion occasionally (type) pale yellow and opaque, the vitta not (type) or only faintly margined with brown in its claval portion; outer apical and outer anteapical cells hyaline, their veins bordered with dark; inner anteapical cell and remaining apical cells smoky, the apices of the first and second traversed by short narrow pale vitta. Face dull gray (type) to pale yellow, a dark-margined pale transverse vitta extending from eye to eye through ocelli, clypellus, lora and portion of adjacent genae darker. Prosternal region dark, remainder of thoracic venter gray, abdomen paler gray, female seventh sternum dark-tipped. Female pygofer grayish brown. Legs pale, hind tarsi with two black annuli.

This species is known only from the type and two paratypes, from Chapada, Brazil, in the U. S. National Museum.

In addition to the characters in the key, the distinctive shape of the aedeagal processes will serve to separate this from other species in the genus.

Paralebra decurvata, new species

FIGURE 5,*c–g*

Length of male, 3.0 mm. Crown with median length one-third greater than interocular width and slightly more than two-thirds length of pronotum; disc convex; width of head including eyes less than width of pronotum. Ocelli as in *P. similis* (Baker). Pronotum with lateral margins strongly divergent posteriorly. Face convex in profile. Hind wing with posterior branch of vein R entire apically. Male plates exceeding posterior pygofer margin, setae as in *P. singularis* (Baker); pygofer with posterior margin regularly convex; a process arising on each side below middle of disc, extending across midline and decurved in caudal aspect, rounded apically; a rod-like process consisting of differentially sclerotized portion of pygofer wall extending horizontally across disc. Ninth tergite triangular, bounded laterally and apically by rod-like heavily sclerotized lines. Anal processes absent. Style slender, broadest anteapically, apex decurved. Aedeagus with preatrium distinct; dorsal apodeme short, liguliform; a pair of atrial processes, broader and shorter than shaft, each gradu-

ally tapered in apical half, extending parallel to shaft, each with apex acute and curved dorsad; shaft setiform, regularly curved caudodorsad.

Ground color of crown clouded ivory. Pronotum pale yellow, with lateral margins deep and a transverse marking in middle of disc paler, orange. Scutellum dull yellow, a marginal spot on each lateral margin opposite end of sulcus, and apex, black. Forewing with basal half of clavus and adjoining portion of corium translucent marked with dull orange; remainder of forewing lacteus with a transcommissural narrow band extending from costal margin to costal margin slightly before midlength of clavus, an arcuate narrow pink line across clavus in its apical half contiguous with a similarly colored arcuate line through brachial cell, a smoky spot before apex of clavus, a broad smoky vitta extending from middle of disc of corium apicad along vein Cu, confluent with a second smoky vitta extending from costal margin beyond its midlength caudomesad through apex of cell R, the two vittae filling claval apex and apical portions of cells R, M and Cu, basal portions of first and second apical cells and most of third apical cell; apical portions of second and third apical cells narrowly smoky; apical cross-veins pale. Face and thoracic venter stramineous; pleural portion of pronotum pink; hind tibiae with outer row of setae set in black spots, and with tibial apex, apex of first tarsomere and all of apical tarsomere, black.

Holotype male, Mojinga Swamp, Panama Canal Zone, Nov. 15, 1951 (F. S. Blanton), in U. S. National Museum (No. 62674).

From other species of the genus, *decurvata* is readily recognizable by its strong, decurved male ventral pygofer processes and its setiform aedeagal shaft.

Genus *Trypanalebra* Young

Figure 6

Trypanalebra Young, Univ. Kansas Sci. Bull. 35, p. 27, 1952 (type *Protalebra maculata* Baker by original designation).

Hind wing with submarginal vein confluent with apical wing margin; posterior branch of vein R entire apically; vein Cu_2 confluent with submarginal vein near midlength of wing, occasionally almost opposite vein m-cu. Forewing with appendix not extending around wing apex which is smoothly rounded; inner apical cell broader at base than at apex; second apical cell parallel-sided; third apical cell variable interspecifically, from sessile to triangular or petiolate. Female seventh sternum with hind margin slightly produced at middle, caudolateral angles rounded; pygofer with multiseriate pale macrosetae parallel to ovipositor. Male plates narrow, elongate, triangular, equal to or exceeding posterior pygofer margin, each with a longitudi-

nal row of macrosetae. Pygofer with hind margin produced and rounded; macrosetae in a vertical or oblique discal row; a pair of processes arising one on each side from inrolled posterior margin or from ventral margin and a weak process on each side arising from dorsal margin and extending ventrad. Ninth tegum with a narrow transverse tergite separated posteriorly and occasionally laterally by a line of flection. Anal processes absent. Style long or short, without preapical lobe. Connective membranous. Aedeagus with preatrium usually absent; dorsal apodeme unpaired, laterally compressed; a conspicuous ventral unpaired atrial process much longer than shaft which is short, directed caudodorsad and usually has a pair of processes arising at base or more distad along its length. Sternal abdominal apodemes traversing first conjunctiva. Head moderately to strongly produced; ocelli on rounded margin between crown and face. Pronotum broader than head including eyes; lateral margins strongly divergent posteriorly. Face convex in lateral aspect.

Distribution: Southwestern United States, Central America, and West Indies.

Trypanalebra is closely related to *Blarea,* in the discussion of which distinguishing characters are mentioned.

Key to species of *Trypanalebra*

1. Crown with four black spots along anterior margin; aedeagal shaft without processes . . . . **blantoni,** new species
   Crown not so marked; aedeagal shaft with paired processes 2
2. Crown with median length greater than interocular width; forewing with cell R not in contact with all apical cells; male with pygofer process elongate, arising on ventral pygofer margin . . . . **ziczac** (Osborn)
   Crown with median length less than interocular width; forewing with cell R in contact with all apical cells; male with pygofer process short, formed by inrolled posterior pygofer margin 3
3. Aedeagus with dorsal processes arising from shaft, greatly exceeded in length by shaft . . . . **maculata** (Baker)
   Aedeagus with dorsal processes arising from dorsal apodeme, almost as long as shaft . . . . **balli,** new species

Trypanalebra maculata **(Baker)**

FIGURE 6,*a–f*

Protalebra maculata Baker, Invertebrata Pacifica, vol. 1, p. 6, 1903.
Protalebra (*Paralebra*) *pardalis* McAtee, Journ. New York Ent. Soc., vol. 34, p. 151, 1926.
Trypanalebra maculata; Young, Univ. Kansas Sci. Bull. 35, p. 28, 1952.
Trypanalebra sp. Young, op. cit., p. 157, fig. 26.

Length of both sexes, 2.5–2.6 mm. Head moderately produced with anterior margin broadly rounded in dorsal aspect; median length of crown one-fourth less than interocular width; disc convex; ocelli

closer to eyes than to median line of head. Pronotum two-thirds longer than crown. Female seventh sternum with hind margin obtusely angulate at middle; pygofer with macrosetae sparse, occurring along posterior half of ovipositor. Male plates each with single row of macrosetae on distal two-thirds. Male pygofer with process

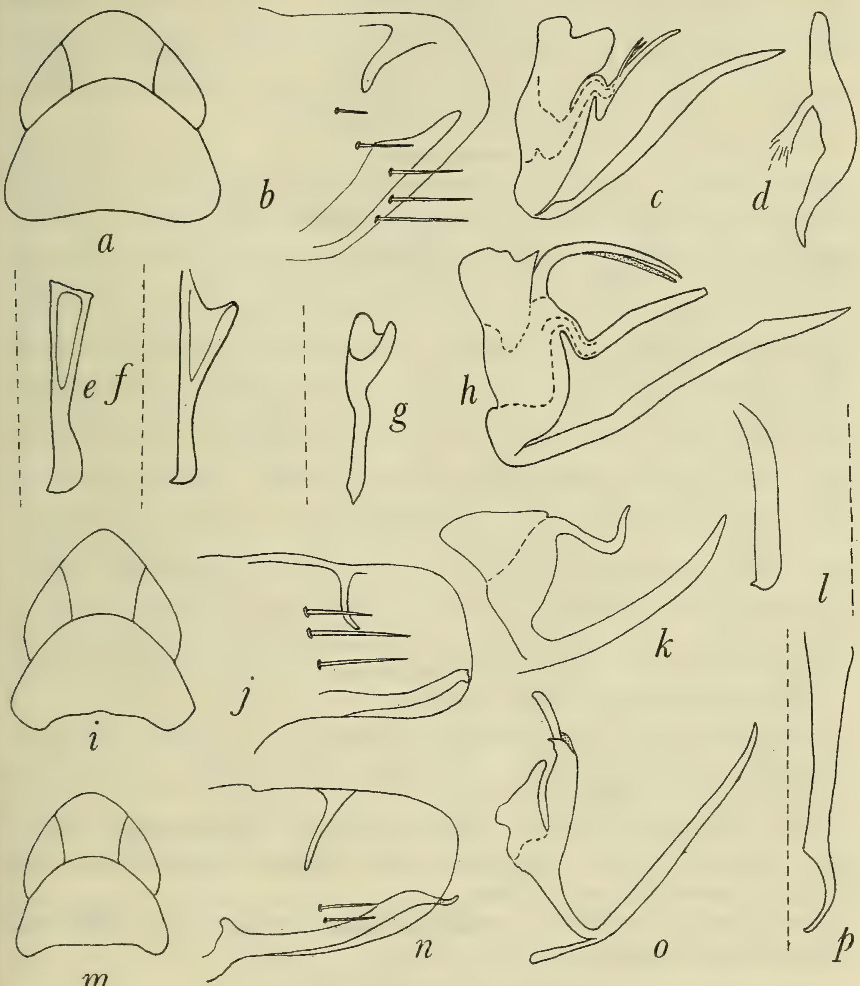

FIGURE 6.—*Trypanalebra.* *a–f*, *T. maculata:* *a*, anterior dorsum; *b*, pygofer, lateral aspect; *c*, aedeagus, lateral aspect; *d*, style, ventral aspect; *e*, pygofer process, caudal aspect (median line broken) (specimen from Chinandega, Nicaragua); *f*, same (specimen from Guadalajara, Mexico). *g–h*, *T. balli:* *g*, pygofer process, caudal aspect (median line broken); *h*, aedeagus, lateral aspect; *i–l*, *T. blantoni:* *i*, anterior dorsum; *j*, pygofer, lateral aspect; *k*, aedeagus, lateral aspect; *l*, pygofer process, ventral aspect; *m–p*, *T. ziczac* (allotype): *m*, anterior dorsum; *n*, pygofer, lateral aspect; *o*, aedeagus, lateral aspect; *p*, pygofer process, ventral aspect.

arising on posteroventral margin, variable in shape in lateral aspect but not exceeding posterior pygofer margin and rounded apically, in ventral aspect its apex in the shape of a pruning knife. Ninth tergite delimited laterally by a line of flection. Style short, apical portion slightly decurved, apex acute. Aedeagus with preatrium absent; dorsal apodeme bilobed; unpaired ventral process much broader than shaft which is curved abruptly ventrad bear base thence abruptly dorsad and curving slightly caudad in apical half of length, giving off a pair of short narrow inconspicuous processes in basal half, these greatly exceeded by apex of shaft.

Ground color of dorsum deep shining black, a diamond-shaped median subapical spot and a laterobasal spot on each side touching inner margin of eye on crown, a median campanulate marking bordering anterior margin, a pair of large irregularly rounded discal markings at midlength, a smaller median marking behind middle, the lateral and posterior margins of the pronotum narrowly, the basal angles narrowly and a large V-shaped marking on the scutellum, four spots in basal half, one in apical half, and a small dot in apex of clavus, three spots in basal half, a very small brachial spot near midlength, two spots opposite anteapical claval spot, a small spot contiguous to apical claval spot veins bordering apex of cell R, and extreme apex narrowly, of corium, bright yellow, three anteapical areoles along costal margin subhyaline. Face black except a transverse basal band between ocelli and continuing to ocellocular areas there surrounding a black spot on each side, and apex of clypellus and genae, yellow. Legs dull gray, a broad postfemoral and posttibial area and extreme apex of latter, dark; thorax dark; abdomen dull gray to black in male, dark in female except pale seventh sternum.

Specimens have been examined from San Marcos, Managua, Granada, and Chinandega, Nicaragua; Concepción, Guatemala; La Ceiba and Zamorano, Honduras; Pico Turquino, Cuba; Puebla, Mexico; Totalapan, Oaxaca, Mexico; Tucson, Baboquivari Mountains, Santa Catalina Mountains, and Sabino Canyon, Ariz.; Del Rio and Cameron County, Tex.

The type of *Protalebra pardalis* McAtee, in the U. S. National Museum, has been studied.

Trypanalebra balli, new species

Figure 6,*g–h*

Length of male, 2.9 mm. Head as in *T. maculata* (Baker). Pronotum almost twice length of crown. Male plates each with single row of macrosetae over middle third; pygofer processes located as in *maculata* but more slender at apex in ventral aspect. Style as in *maculata*, but longer. Aedeagus with shaft and unpaired ventral

process much similar to *maculata;* a pair of dorsal processes arising from dorsal apodeme, much more conspicuous than in the latter species, curved caudoventrad and almost as long as shaft.

Color of dorsum as in *maculata*. Face entirely pale yellow except for two black spots on margin between crown and face, and one on each ocellocular area. Thoracic venter and legs as in genotype.

Described from a single male from Tinajas Altas, Ariz., Apr. 23, 1935 (E. D. Ball), in the U. S. National Museum (No. 62675).

Trypanalebra blantoni, new species

FIGURE 6,*i–l*

Length of male 2.5 mm., of female 2.5–2.6 mm. Head strongly produced with anterior margin acutely rounded in dorsal aspect; median length of crown more than one-half greater than interocular width; disc flat or slightly concave; ocelli about equidistant from inner eye margins and median line of head. Pronotum equal to crown in length. Female seventh sternum with posterior margin regularly convex; pygofer with macrosetae more closely spaced than in *T. maculata* (Baker), occurring along posterior two-thirds of length of ovipositor. Male plates with row of macrosetae extending from near base almost to apex. Male pygofer with process arising along ventral margin, the two processes subparallel, extending caudad but not exceeding posterior pygofer margin, each with apex rounded and with small lateroventral subapical projection. Ninth tergum delimited posteriorly, but not laterally, by a line of flection. Style as in *maculata*. Aedeagus with preatrium absent; dorsal apodeme convex dorsally, not lobed; unpaired ventral process much broader than shaft which is broadly U-shaped in lateral aspect; shaft processes absent.

Crown ivory with four black spots along anterior margin and a pair of indistinct laterobasal pale yellow spots, one next inner margin of each eye. Pronotum yellow, bordered with white posteriorly, with a black dash along the anterior margin of the white border on each side, each humeral margin with a dark spot. Scutellum with basal angles yellow with a median longitudinal dark mark between them; apical half ivory; transverse sulcus, a spot on each lateral margin at midlength and apex, black. Forewing olive green striped with fuscous in basal half, smoky with pale veins in apical half; a small spot in corium near base of claval suture, a large spot along costa including plaque, inner apical cell, and an arcuate transcommissural marking extending through apical half of clavus and through brachial cell, lacteus, partly bordered with black or fuscous; third apical cell black. Face and venter pale.

Holotype and paratype males from Las Tablas, Los Santos Province, Panama, and male paratype from El Real, Darién Province, Panama,

in U. S. National Museum (No. 62676). Other Panama specimens of both sexes examined from Fort Clayton and Mojinga Swamp, Panama Canal Zone; Garachiné, Darién Province; Paris and Parita, Herrera Province; Río Hato and Aguadulce, Coclé Province; and Arraijan and Tocumen, Panamá Province. All of the specimens were collected by F. S. Blanton, in whose honor the species is named.

Trypanalebra ziczac (Osborn), new combination

FIGURE 6,*m–p*

Protalebra ziczac Osborn, Journ. Dep. Agr. Porto Rico, vol. 13, p. 104, 1929.

Length of male 2.5 mm., of female 2.5–2.7 mm. Head strongly produced with anterior margin broadly rounded in dorsal aspect; median length of crown one-seventh greater than interocular width; disc flat or slightly convex; ocelli slightly closer to median line than to inner eye margins. Pronotum one-fifth longer than crown. Female seventh sternum with hind margin rectilinear, caudolateral angles rounded; pygofer setae more dispersed than in *T. blantoni* Young and occurring along almost entire length of ovipositor. Male plates each with single row of macrosetae from near base to apex. Male pygofer with process arising on ventral margin near base, elongate, slightly exceeding posterior pygofer margin in lateral aspect, gradually tapered and bisinuate apically, in ventral aspect the two processes parallel, gradually tapered through most their length, each with apical portion crescentiform with the concave surface medial. Ninth tergum and style as in *blantoni*. Aedeagus with dorsal apodeme weakly lobed on dorsal margin; unpaired ventral process about as wide as shaft; shaft with pair of short lateral anteapical expansions, the processes together forming an equilateral-triangle-shaped design in caudal aspect.

Crown with ground color sordid brownish gray, a cloverleaf-shaped area in anterior half of disc and the hind margin broadly edged with dull ivory. Pronotum and scutellum deep yellow to orange, the former bordered behind with a vitreous rim that is narrowly bordered anteriorly with black. Forewings translucent; each clavus olive yellow to orange, the basal half of inner margin extremely narrowly black, within a narrow hyaline to lacteus vitta parallel to inner claval margin from wing base to slightly behind midlength, extending thence caudolaterad through brachial cell then obtusely angled and extending caudomesad along vein Cu and continuous at its apex with lacteus angulate base of inner apical cell, this elongate zigzag vitta occasionally narrowly bordered with smoky in posterior half its length; olive-yellow or orange of clavus extending into brachial cell near its apex, and extending across claval suture at its midlength into corium in

an arched vitta extending beyond midwidth of corium, thence caudad and narrowing along vein M to yellow or orange base of second apical cell; an oblique vitta extending from behind midlength of costal margin to apex of cell R, and areole of third apical cell darkly, the areoles of first and second apical cells paler, fumose; base of outer apical cell with a black spot next costal margin; costal margin narrowly pale yellow in basal half. Face and venter pale except dark mesothorax.

The type, a female from Mayaguez, Puerto Rico, is probably in the Ohio State University collection. Caldwell (*in* Caldwell and Martorell, 1952, p. 99) selected a male allotype from Vieques Island, Puerto Rico, and it is upon this specimen that the above genitalia description is based.

In addition to Puerto Rico specimens, a pair of specimens collected at Tamazumchale, Mexico, Dec. 23, 1949, by Dr. R. H. Beamer appear to be conspecific with the Puerto Rican forms. The Mexican female is larger, measuring 3.0 mm. The Mexican specimens have dark orange markings against a slate gray background on the wings, and the transverse facial stripe is orange.

Blarea, new genus

FIGURE 7

Type of the genus, *Blarea brasiliensis*, new species.

Hind wing with submarginal vein confluent with apical wing margin; posterior branch of vein R evanescent apically; vein Cu_2 confluent with submarginal vein in basal half of wing, slightly basad of vein m-cu. Forewing with appendix not extending around apical wing margin which is smoothly rounded; inner apical cell not greatly wider at base than at apex; second apical cell slender, parallel-sided; third apical cell sessile, short, much broader at apex than at base; outer apical cell short, longer than broad, its base proximad of base of third apical cell. Male plates triangular in ventral aspect, exceeding posterior pygofer margin, each with single row of macrosetae over apical two-thirds. Pygofer with posterior margin truncate; macrosetae few, in a vertical row on disc; pygofer processes very weak, consisting of differentially sclerotized areas of pygofer wall, one on each side extending from dorsal margin ventrad to middle of disc and one on each side forming an irregular linear area along ventral pygofer margin. Ninth tergum with a trilobed transverse tergite consisting of a pair of slender lateral arms and a small lobate central area, all delimited by lines of flection from remainder of pygofer. Anal processes absent. Style slender, elongate, without preapical lobe, the apical portion curved mesoventrad. Connective membranous. Aedeagus with preatrium

distinct, short; dorsal apodeme laterally compressed; unpaired ventral process gradually tapered from near base to acute apex, longer and broader than setiform shaft. Head very slightly produced, crown with median length less than half interocular width; ocelli on very broadly rounded margin between crown and face, closer to median line than to inner eye margins. Pronotum with median length more than three times median length of crown, wider than head including eyes, lateral margins strongly divergent posteriorly. Face slightly convex in lateral aspect.

Known only from the genotype, from Brazil.

In this genus, the form of the male genitalia indicates a close relationship to *Trypanalebra*. The shorter head, the evanescent posterior branch of vein R in the hind wing, and the lack of paired aedeagal processes in *Blarea* will serve to separate it from the preceding genus.

Blarea brasiliensis, new species

Figure 7

Length of male 3.7 mm. Male plates in lateral aspect each with apical portion a rounded lobe lying in a sagittal plane. Style extending caudad to midlength of plate, bisinuate in lateral aspect. Aedeagus with dorsal apodeme strongly compressed laterally at base, the apex slightly expanded; shaft measured at midlength with width less than one-third adjacent width of ventral process, about three-fourths length of ventral process.

Crown dull yellow with an apical black spot. Pronotum shining deep brown, anterior submarginal area black, posterior and humeral margins broadly yellow. Wings smoky translucent, costal plaque

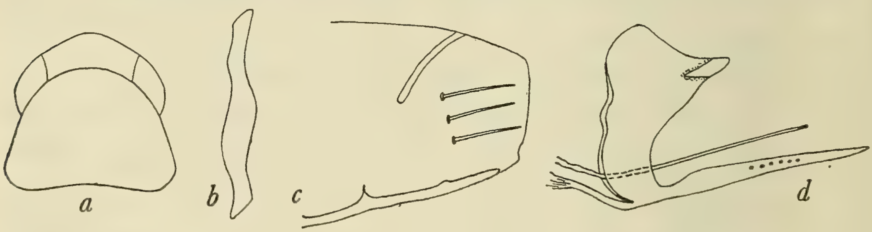

Figure 7.—*Blarea brasiliensis* (type): *a*, anterior dorsum; *b*, style, ventral aspect; *c*, pygofer, lateral aspect; *d*, aedeagus, lateral aspect.

darker, an elongate-oval transcommissural transverse vitta extending slightly laterad of brachial cell of each wing and crossing clavus slightly behind midlength, bright yellow. Face concolorous with crown; clypellus and adjacent apical portion of clypeus black; legs stramineous; remainder of venter black.

Described from a single male from Rezende, Estado de Rio, Brazil, March 1924 (F. X. Williams), in the collection of the Hawaiian Sugar Planters Association.

Relaba, new genus

FIGURE 8

Type of the genus, *Relaba williamsi*, new species.

Hind wing with submarginal vein confluent with apical wing margin to apex of vein M_{1+2}; posterior branch of R occurring as a short spur; vein Cu_2 confluent with submarginal vein at point much basad of vein m-cu. Forewing with appendix not extending around apex which is smoothly rounded; inner apical cell much broader in basal third than in remainder of length; second apical cell parallel-sided; third apical cell very small, triangular, petiolate; outer apical cell with length greatly exceeding width, not attaining apical wing margin. Male plates not exceeding pygofer, each with longitudinal submarginal row of few macrosetae on basal half. Pygofer with posterior

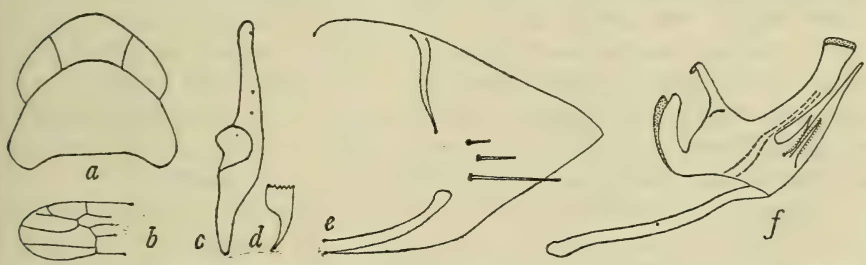

FIGURE 8.—*Relaba williamsi* (type): *a*, anterior dorsum; *b*, apex of forewing; *c*, style, dorsal aspect; *d*, style apex, lateral aspect; *e*, pygofer, lateral aspect; *f*, aedeagus, lateral aspect.

margin produced; disc with few macrosetae in a vertical row; with dorsal and ventral pygofer processes. Ninth tergite distinct, transverse, delimited laterally by a line of flection, anterior margin bilobed. Anal processes absent. Style short, with preapical lobe. Connective membranous. Aedeagus with preatrium elongate; dorsal apodeme paired; paired and unpaired ventral atrial processes present. Sternal abdominal apodemes not traversing first conjunctiva. Head weakly produced, crown with median length less than interocular width; ocelli on rounded margin between crown and face slightly closer to inner eye margins than to median line. Pronotum much longer than crown, wider than head including eyes; lateral margins strongly divergent posteriorly. Face slightly convex in lateral aspect.

Distribution: Ecuador.

The male genitalia suggest a relationship to *Trypanalebra* and *Blarea,* from both of which *Relaba* can be readily separated by its asymmetrical dorsal aedeagal process.

Relaba williamsi, new species

Figure 8

Length of male 4.0 mm. Crown with median length slightly more than two-thirds interocular width and approximately half length of pronotum. Male plates broad basally, each with lateral margin convex and strongly narrowing to mesal margin in basal half, apical half slender and slightly tapered. Pygofer with posterior margin strongly produced and subangulate apically; with few discal macrosetae behind middle of disc; a short, ventral process occurring as thickened edge of inrolled ventral pygofer wall; and a slender acute sclerotized rod arising along dorsal margin, extending ventrad to point near middle of disc. Style very short, in dorsal aspect gradually tapered to slender rounded apex, in lateral aspect with preapical lobe, apical extension short, slightly decurved, acute apically. Aedeagus with preatrium longer than shaft, very slender; dorsal apodeme consisting of two arched lateral arms each extending dorsocaudad; with a median ventral acute unpaired atrial process almost as long as shaft, and a pair of minute acute processes arising near base, one on each side of unpaired process; shaft flared apically, around gonopore, expanded basally and giving off an unpaired slender process which is directed caudodorsad and asymmetrically curved apically.

Crown dull ivory with a pair of round black spots one on each side of median line near anterior margin; disc with a large dull red spot on each side of median line, near middle. Pronotum brick-red, the lateral and humeral margins bordered with ivory and with a longitudinal median ivory vitta, the ivory border occasionally extending completely across hind margin, and confluent with posterior prolongation of median vitta. Scutellum dull yellow, a pair of marginal spots opposite transverse sulcus, and apex, black. Forewing with ground color of clavus and adjacent corium translucent orange; a transcommissural vitta at midlength of clavus extending into corium of each wing, hyaline, bordered with dull smoky; apical portion of each wing hyaline basally and laterally, remainder smoky translucent with a faint transverse hyaline area through appendix and first and second apical cells; apical veins pale; third and fourth apical cells and apex of costal cell bordered with black internally; costa orange in basal half; costal cell with an oblique dark vitta at midlength. Face dull ivory to gray faintly washed with orange near clypeal suture, with a conspicuous interocular orange band below base. Venter and legs pale, except black mesosternum and apex of hind tibia.

Holotype male, Mar. 8, 1923, paratype males, Mar. 25, and Apr. 4, 1923, in collection of Hawaiian Sugar Planters Association and one male paratype, Apr. 4, 1923, in U. S. National Museum. All are from Tena, Ecuador, and were collected by F. X. Williams, in whose honor the species is named.

Genus *Aphanalebra* McAtee

Figure 9

Protalebra subgenus *Aphanalebra* McAtee, Journ. New York Ent. Soc. vol. 34, p. 152. 1926 (type *Protalebra unipuncta* Baker by original designation).
Aphanalebra; Young, Univ. Kansas Sci. Bull. 35, p. 20, 1952.

Hind wing with submarginal vein confluent with apical wing margin; posterior branch of vein R entire apically; vein Cu_2 confluent with submarginal vein at point much basad of vein m-cu. Forewing with appendix not extending around wing apex which is smoothly rounded; veins M and Cu fused before base of inner apical cell; inner apical cell slender, much broader at base than at apex; second apical cell angular at base, petiolate, slender; third apical cell very small, triangular, long-petiolate; outer apical cell open basally, almost attaining apical wing margin. Female seventh sternum produced posteriorly, the hind margin convex on each side of a shallow V-shaped median excision; pygofer with macrosetae on posterior two-thirds. Male plates triangular, elongate, exceeding posterior pygofer margin, each with oblique row of macrosetae in apical half. Male pygofer with apex truncate; macrosetae arranged in an irregular oblique group over disc; processes absent. Ninth tergum a heavily sclerotized transverse area without lines of flection laterally or apically. Two pairs of anal processes present. Style elongate, without a preapical lobe, the apex slightly decurved. Connective membranous. Aedeagus with preatrium absent; dorsal apodeme Y-shaped with arms widely spaced, giving off a unilateral process that extends caudad almost to apex of shaft; shaft elongate, bisinuate, recurved apically; gonopore terminal. Head produced with anterior margin broadly

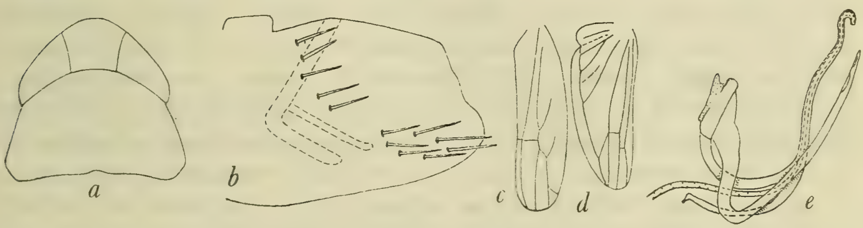

Figure 9.—*Aphanalebra unipuncta*: *a*, anterior dorsum (type); *b*, pygofer, lateral aspect (anal process in broken line) (type); *c*, forewing; *d*, hind wing; *e*, aedeagus, lateral aspect (type).

rounded; crown with median length equal to interocular width; ocelli on broad margin between crown and face, about equidistant from inner eye margins and median line of head. Pronotum twice length of crown, wider than head including eyes; lateral margins strongly divergent posteriorly. Face flat in profile.

Distribution: Brazil.

The characters in the key will easily separate *Aphanalebra* from other alebrine genera. The form of the aedeagus is unique in the tribe.

Aphanalebra unipuncta (Baker)

Figure 9

Protalebra unipuncta Baker, Psyche, vol. 8, p. 404, 1899.
Aphanalebra unipuncta; Young, Univ. Kansas Sci. Bull. 35, p. 20, 1952.

Length of male 3.1 mm., of female 3.2–3.3 mm. Male pygofer with posterior margin truncate, macrosetae arranged in an oblique group over disc. Style with apex appearing truncate in dorsal aspect. Other characters as in generic description.

Crown dull ivory with a single apical round black spot. Pronotum olive yellow with a pair of oblique oval markings, one on each side of median line, and a pair of horizontal dashes, one on each side near posterior margin, black. Scutellum orange-yellow, the basal angles, a median streak in basal half and extreme apex, black. Forewing with costal margin broadly hyaline and a transverse transcommissural hyaline area extending to midcorium of each wing across midlength of clavus; basal half of clavus orange with a longitudinal curved black streak that widens apically to border the hyaline area anteriorly; posterior third of clavus, adjacent corium and apical cells except outer, smoky; longitudinal veins pale orange. Face and venter sordid yellow.

This species was originally described from four specimens from Chapada, Brazil. A male of the original series, No. 29519 in the U. S. National Museum, bears a type label. This specimen is here designated lectotype. The other three specimens bear "paratype" labels with the same catalog number, presumably affixed by McAtee in 1926.

Osbornulus, new genus

Figure 10

Type of the genus, *Dikraneura quadrifasciata* Osborn.

Hind wing with submarginal vein confluent with apical wing margin; posterior branch of vein R entire apically; vein Cu_2 confluent with submarginal vein at point considerably proximad of vein m-cu. Forewing with appendix not extending around apex which is smoothly

rounded; inner apical cell narrowest at base, gradually broadening throughout its length; second apical cell almost parallel-sided; third apical cell sessile; outer apical cell longer than broad, its base distinctly proximad of base of third apical cell. Male plates triangular, exceeding posterior pygofer margin, each with single longitudinal row of macrosetae over middle half. Pygofer with posterior margin slightly angularly produced posteriorly; macrosetae irregularly arranged over posterior half of disc; two processes on each side occurring as differentially sclerotized areas of the pygofer wall, one along posteroventral margin, slender basally, broadened at pygofer apex,

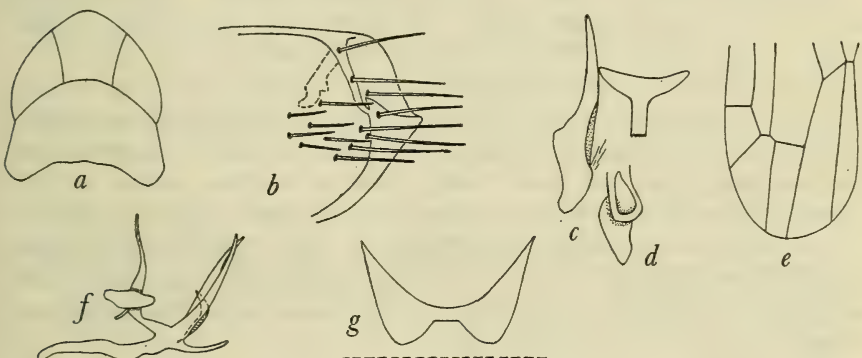

FIGURE 10.—*Osbornulus quadrifasciatus: a*, anterior dorsum; *b*, pygofer, lateral aspect; *c*, style, lateral aspect, and connective; *d*, style apex, ventral aspect; *e*, apex of forewing; *f*, aedeagus, lateral aspect (type); *g*, sternal abdominal apodemes, ventral aspect (broken line represents conjunctiva).

the other extending along posterior pygofer margin then caudoventrad across posterior half of disc to the first process. Ninth tergite distinct, transverse, bounded laterally by distinct integumental thickenings. Anal processes occurring as a distinct anal collar, extending ventrad to middle of pygofer disc. Style short, without distinct preapical lobe. Connective T-shaped, strongly joined to base of aedeagus. Aedeagus with preatrium elongate, giving rise to two pairs of ventral processes; dorsal apodeme transverse; shaft slender, without processes. Sternal abdominal apodemes not traversing first conjunctiva. Head strongly produced, crown with median length exceeding interocular width; ocelli on rounded margin between crown and face, about equidistant from inner eye margins and median line of head. Pronotum longer than crown, wider than head including eyes; lateral margins slightly divergent posteriorly. Face slightly convex in lateral aspect.

This genus is named in honor of the late Prof. Herbert Osborn of the Ohio State University, who made many contributions to our knowledge of Cicadellidae.

Distribution: Bolivia and Brazil.

Osbornulus does not appear to be closely related to any of the other genera in the tribe. The form of the aedeagus with its two pairs of atrial processes serves to separate *Osbornulus* from all of the following genera.

Osbornulus quadrifasciatus (Osborn), new combination

Figure 10

Dikraneura quadrifasciatas Osborn, Ann. Carnegie Mus. vol. 18, p. 272, 1928.
Elabra quadrifasciata; Young, Univ. Kansas Sci. Bull. 35, p. 35, 1952.

Length of male 3.8 mm. Crown with disc concave, median length almost twice interocular width and more than two-thirds median length of pronotum. Other characters as in generic description.

Ground color of dorsum lacteus, a pair of vittae beginning on disc of crown, extending caudad, diverging over pronotum and scutellum, extending entire length of each forewing parallel to commissure, around wing apex and basad along costa to its base, amber to pale brown, interrupted by white claval suture and a pair of oblique white vittae at and behind midlength of costa; posterior two-thirds of claval commissure white. Face and venter pale, an amber dash across pleural portion of pronotum on each side, apical hind tarsomere black.

The holotype, a male from Provincia del Sara, Bolivia, is in the Carnegie Museum collection. Additional specimens have been examined from Rio Caraguata, Mato Grosso, Brazil.

Genus *Protalebra* Baker

Figure 11

Protalebra Baker, Psyche, vol. 8, p. 402, 1899 (type *Alebra curvilinea* Gillette, by original designation).

Hind wing with submarginal vein confluent or not with apical wing margin; posterior branch of vein R entire apically; vein Cu_2 confluent with submarginal vein at point much basad of vein m-cu. Forewing with appendix not extending around wing apex which is smoothly rounded; inner apical cell wider in basal third than at apex; second apical cell parallel-sided; third apical cell stalked; outer apical cell elongate, trapezoidal, not attaining apical wing margin, its base distinctly proximad of base of third apical cell. Male plates triangular, attaining or exceeding posterior pygofer margin, abruptly narrowed at midlength, each with a single row of macrosetae extending from near base to apex. Pygofer with posterior margin produced; macrosetae numerous, irregularly arranged on disc; pygofer processes arising ventrally or absent. Ninth tergum with or without a tergite. Anal processes present, straight, slender, variable in length inter-

specifically. Style elongate, slender, without a distinct preapical lobe; apex slightly decurved. Connective Y-shaped. Aedeagus with preatrium absent; dorsal apodeme vestigial or present and transverse or paired; with a conspicuous asymmetrical dorsal process; shaft slender, elongate, without processes. Head strongly produced; crown with median length exceeding interocular width; ocelli on rounded margin between crown and face, about equidistant from inner eye margins and median line of head. Pronotum with median length exceeding length of crown, wider than head including eyes; lateral margins strongly divergent posteriorly. Face convex in lateral aspect.

Distribution: Brazil, Argentina, and Virgin Islands.

Key to species of *Protalebra*

1. Male pygofer with dorsal processes only, discal and ventral processes absent; aedeagus with paired dorsal apodemes, each arm bilobed apically. **nexa** McAtee
   Male pygofer with discal and ventral pygofer processes in addition to dorsal; aedeagus with dorsal apodeme a transverse bar or absent. 2
2. Aedeagus with dorsal process slender and cylindrical, not broader than shaft; dorsal aedeagal apodeme vestigial. . . . . **haywardi,** new species
   Aedeagus with dorsal process broad, not cylindrical, conspicuously broader than shaft; dorsal aedeagal apodeme a transverse bar . **curvilinea** (Gillette)

Protalebra curvilinea (Gillette)

Figure 11,*a–f*

Alebra curvilinea Gillette, Proc. U. S. Nat. Mus., vol. 20, p. 710, 1898.
Protalebra curvilinea; Baker, Psyche, vol. 8, p. 405, 1899.

Length of female 3.2 mm. Crown with median length less than one-third greater than interocular width and two-thirds median length of pronotum. Hind wing with submarginal vein not confluent with apical wing margin. Female seventh sternum large, hind margin strongly produced in a broad lobe which is obliquely convex on each side of the straight apex; pygofer heavily setose with pale setae on each side of the ovipositor throughout its length, a few of the setae contrasting black. Male plates exceeding posterior pygofer margin. Male pygofer with posterior margin lobed ventrally, with an almost straight ventral process extending from near base caudo-dorsad to apical margin of pygofer, the two processes convergent in their apical halves in ventral aspect but not approximate apically; dorsal margin with a differentially sclerotized integumental bar extending to midlength of margin, thence curved abruptly ventrad to slightly above middle of disc; disc with a second such bar extending horizontally from near middle to apex; tergum with a basal transverse heavily sclerotized bar with a median triangular posterior projection. Anal processes strong, slender, extending ventrad beyond middle of

disc of pygofer. Connective membranous near its articulation with styles, with a Y-shaped heavily sclerotized median portion which is bilobed apically. Aedeagus with dorsal apodeme a transverse bar; with a large asymmetrical dorsal process about as long as shaft.

Ground color of crown, pronotum and scutellum ivory, a transverse undulate vitta between eyes, a transverse vitta completely across pronotum before middle, and basal angles of scutellum, dull yellow. Forewings hyaline with an omega-shaped lacteus marking on a pale yellow background intersecting commissural margin just behind scutellum, bordering inner margin of costal plaque laterally, extending thence to claval apex, thence caudolaterad to outer apical cell, the anterior transverse portion bordered narrowly with black before and behind. Face and venter entirely pale.

Known only from the male type and a female paratype from Chapada, Brazil, in the U. S. National Museum.

Protalebra haywardi, new species

FIGURE 11,*g–j*

Length of male 2.8 mm. Crown with median length almost one-half greater than interocular width and two-thirds median length of pronotum. Hind wing with submarginal vein confluent with apical wing margin. Male plates as in *P. curvilinea* (Gillette) but not exceeding posterior pygofer margin; pygofer with ventral portion of posterior margin produced posteriorly in an acute lobe; a process arising ventrally, distad of anterior half of ventral margin, weak, extending caudodorsad, not attaining posterior margin; dorsal and discal integumental bars present as in *curvilinea* but with latter more oblique and beginning almost at anterior pygofer margin; tergum with transverse bar as in *curvilinea* but without the triangular projection. Anal processes forming an anal collar, not extending ventrad to discal region of pygofer in lateral aspect. Connective short, Y-shaped, with bilobed apical portion, completely sclerotized. Aedeagus with dorsal apodeme vestigial; with a conspicuous elongate slender process, no wider than shaft in lateral aspect, arising dorsad of shaft, extending caudad thence dorsocephalad, apex sharply rounded in lateral aspect, bifid in ventral aspect; shaft slender, elongate, extending parallel to dorsal process almost to apex.

Ground color of crown, pronotum, and scutellum ivory, a faint transverse line across disc of crown between eyes dull orange; a transverse vitta across basal portion of disc of pronotum with an acute median posteriorly directed tooth, a trilobed transverse marking across base of scutellum and the median line of the scutellum to apical third, orange yellow. Forewings with ground color translucent yellow, a lacteus circle crossing commissure just behind scutellar apex

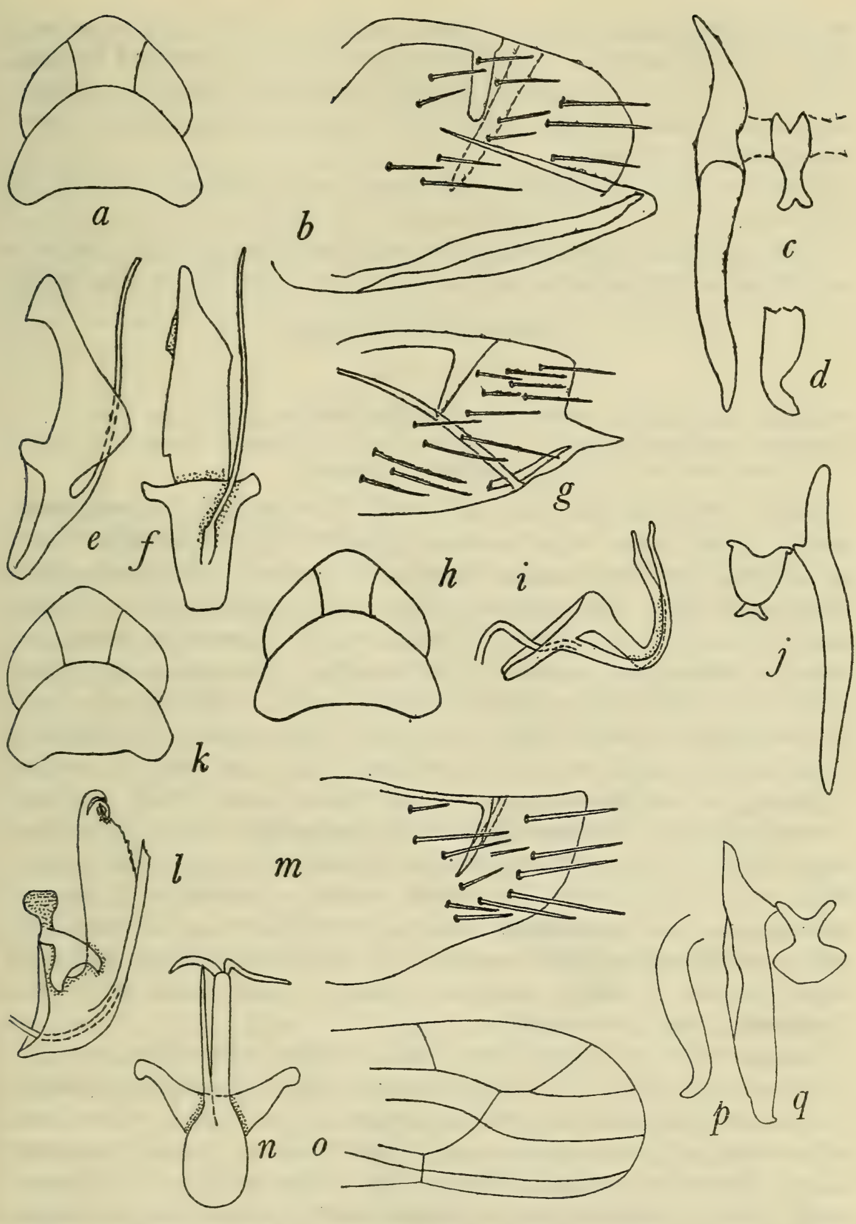

FIGURE 11.—*Protalebra.* *a–f*, *P. curvilinea* (type): *a*, anterior dorsum; *b*, pygofer, lateral aspect (broken line is anal process); *c*, style and connective, dorsal aspect; *d*, style apex, lateral aspect; *e*, aedeagus, lateral aspect; *f*, the same, caudal aspect. *g–j*, *P. haywardi* (type): *g*, pygofer, lateral aspect; *h*, anterior dorsum; *i*, aedeagus, lateral aspect; *j*, style and connective, dorsal aspect. *k–q*, *P. nexa*: *k*, anterior dorsum; *l*, aedeagus, lateral aspect; *m*, pygofer, lateral aspect; *n*, aedeagus, caudal aspect; *o*, apex of forewing (type); *p*, style apex, lateral aspect; *q*, style and connective, ventral aspect.

and at claval apex, bordering inner margin of costal plaque on each wing, and with an arched extension on each wing from apex of brachial cell to apex of cell R; apical cells subhyaline with a small black spot in areoles of first, second, and third. Face, pleural portion of pronotum and venter pale.

Holotype male, Tucumán, Argentina, January–March 1941 (K. J. Hayward), in U. S. National Museum (No. 62887).

This species is closely related to *curvilinea* from which it may be distinguished by the characters in the key and in the above description.

Protalebra nexa **McAtee**

Figure 11,*k–q*

Protalebra nexa McAtee, Journ. New York Ent. Soc. vol. 34, p. 150, 1926.
Protalebra insularis Caldwell, *in* Caldwell and Martorell, Journ. Agr. Univ. Puerto Rico, vol. 34, p. 94, 1952, new synonymy.

Length of male 2.6 mm., of female 2.7–2.8 mm. Crown with median length more than one-half greater than interocular width and slightly less than median length of pronotum. Hind wing with submarginal vein not confluent with apical wing margin. Female genitalia as in *P. curvilinea* (Gillette) but with posterior margin of seventh sternum less convex and without dark macrosetae on pygofer. Male plates exceeding posterior pygofer margin. Male pygofer with posterodorsal portion produced posteriorly, subangulate; pygofer with dorsal integumental bar as in *curvilinea*, the apical vertical portion extending to middle of pygofer disc; ventral and discal processes wanting; tergum without differentially sclerotized area. Anal processes confluent with lower portion of vertical part of pygofer process. Style weakly biundulate in lateral aspect. Connective Y-shaped with apical portion expanded. Aedeagus with dorsal apodeme paired, each arm diverging from long axis of shaft and bilobed apically; dorsal process laterally compressed, longer than shaft, with pair of asymmetrical appendages at apex.

Ground color of crown ivory with a faint yellow tint on disc. Pronotum deep yellow, the lateral margins, humeral margins, posterior margin and two anterior extensions from it, ivory. Scutellum deep yellow with an ivory spot on each side of disc at end of transverse sulcus. Forewing lacteus, clavus with a spot at base, a]-shaped marking at midlength and an anteapical dash, corium with an oblique dash near base, a similar one bordering anterior half of costal plaque and expanding at claval suture, and a line before apical cells on veins M and Cu, yellow, the marking near claval apex sometimes orange; an oblique line behind costal plaque, apex of vein R, and base of outer apical cell black, an oblique irregular marking from apex of clavus to costal margin at third apical cell, involving basal portions

of apical cells, ivory bordered with black; apical margin broadly smoky. Face, venter and pleural portion of pronotum pale, the posttibiae with apices, and a few of spines, black.

The female holotype and two female paratypes from St. Thomas, Virgin Islands, and the male holotype of *Protalebra insularis* Caldwell from the same island are in the U. S. National Museum. No other specimens have been seen.

This species differs from the two preceding species in its lack of discal and ventral processes on the pygofer, its possession of paired and lobed aedeagal apodemes, and its lack of an omega-shaped pattern on the dorsum.

Genus *Balera* Young

FIGURES 12, 13

Balera Young, Univ. Kansas Sci. Bull. 35, p. 25, 1952 (type *Dikraneura pellucida* Osborn by original designation).

Hind wing with submarginal vein distinct and free from apical wing margin; posterior branch of vein R entire; vein Cu_2 confluent with submarginal vein near midlength of wing, much basad of vein m-cu. Forewing with appendix not extending around wing apex which is smoothly rounded; all apical cells much longer than broad, parallel-sided, angulate basally, their bases (except first) almost in same transverse line; outer apical cell almost attaining apical wing margin. Male plates exceeding posterior pygofer margin, slightly beaked apically in lateral aspect, each with single or double row of weak macrosetae. Pygofer produced posteriorly, occasionally forming an apical process which is not differentially sclerotized, without discal macrosetae, with group of small macrosetae near and parallel to posterodorsal margin. Ninth tergum without a tergite or differentially sclerotized area. Anal processes weak or absent. Style sigmoid in lateral aspect. Connective V- or Y-shaped. Aedeagus with preatrium present or absent; dorsal apodeme absent or present and variable interspecifically; shaft with one or two pairs of apical or anteapical processes. Sternal abdominal apodemes slender and elongate, usually capitate apically, traversing one or two abdominal conjunctivae. Head slightly produced with apex rounded or obtusely angulate; ocelli on broadly rounded margin between crown and face, about midway between median line of head and inner eye margins. Pronotum more than one-half longer than head, broader or narrower than head including eyes; lateral margins subparallel or divergent posteriorly. Face flat to slightly convex, widely divergent from crown in profile.

Distribution: Panama, Trinidad, Brazil, and Bolivia.

The peculiar styles of the males, the capitate elongate sternal abdominal apodemes, and the chaetotaxy of the pygofer set *Balera* well apart from all other alebrine genera.

Key to species of *Balera*

1. Aedeagus with shaft greatly inflated throughout its length, with three apical lobes . . . . **pellucida** (Osborn)
   Aedeagus not so 2
2. Aedeagus with a pair of preapical lateral keels and an apical spiniform process. **pusilla,** new species
   Aedeagus not so 3
3. Aedeagus with two pairs of apical processes, both pairs standing out from shaft . . . . **emarginata** (Osborn)
   Aedeagus with a single pair of elongate retrorse subapical processes appressed to shaft. . . . . **caraguatae,** new species

Balera pellucida **(Osborn)**

Figure 12,*a–e*

Dikraneura pellucida Osborn, Ann. Carnegie Mus., vol. 18, p. 271, 1928.
Balera pellucida; Young, Univ. Kansas Sci. Bull. 35, p. 26, 1952.

Length of male 2.7 mm. Crown short, triangular, the apex broadly rounded; median length seven-eighths interocular width and almost two-thirds median length of pronotum which is not as broad as head including eyes. Male plates each with double row of macrosetae on basal half. Pygofer with posterior margin produced to narrow process which is directed mesad and not differentially sclerotized. Style sigmoid in apical half, with preapical setae on ventral surface. Connective V-shaped. Aedeagus inflated, preatrium very short; dorsal apodeme weak; shaft keeled laterally with keels widened apically to form pair of membranous lobes which extend dorsolaterally and are continuous through a similar ventral subapical lobe which extends ventrad. Sternal abdominal apodemes scarcely traversing first conjunctiva.

The type has faded. Original description: "Pale yellowish; vertex and front and anterior part of pronotum tinged with fulvous; elytra subhyaline; clavus tinged with yellow and with dusky apex; apical cells slightly smoky; beneath pale yellow."

The holotype, a male from Bolivia, is in the Carnegie Museum.

The form of the aedeagus will readily separate this from other species of the genus.

Balera caraguatae, **new species**

Figure 12,*f–l*

Length of male 3.3–3.6 mm. Crown short, triangular, the apex broadly rounded; median length more than two-thirds interocular width and more than two-thirds length of pronotum which is slightly

wider than head including eyes; lateral pronotal margins slightly divergent posteriorly. Male plates each with single or double row of weak macrosetae on basal half. Pygofer in lateral aspect with posterodorsal portion produced, the posteroventral margin oblique and broadly convex. Style narrow, short, not greatly exceeding apex

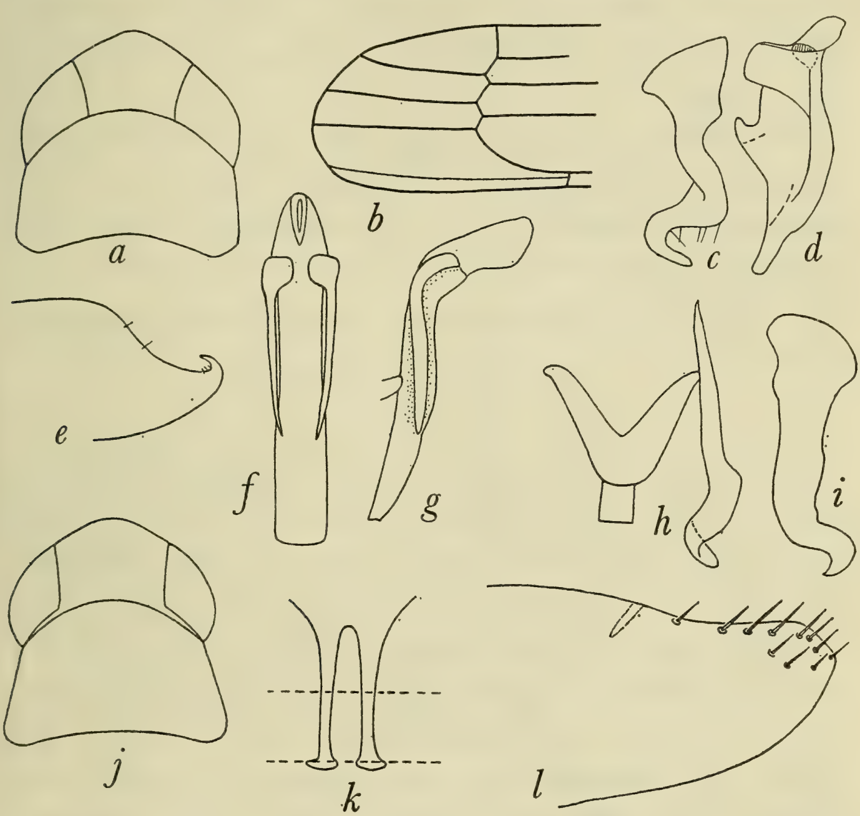

FIGURE 12.—*Balera*. *a–e*, *B. pellucida* (type): *a*, anterior dorsum; *b*, apex of forewing; *c*, style, lateral aspect; *d*, aedeagus, lateral aspect; *e*, pygofer, lateral aspect. *f–l*, *B. caraguatae* (type): *f*, aedeagus, dorsal aspect; *g*, same, lateral aspect; *h*, style and connective, dorsal aspect; *i*, style, lateral aspect; *j*, anterior dorsum; *k*, sternal abdominal apodemes, ventral aspect (broken lines represent abdominal conjunctivae); *l*, pygofer, lateral aspect.

of connective; apical half sigmoid in lateral aspect with the apex acute and curved ventrad. Connective Y-shaped, the unpaired portion very short. Aedeagus slightly compressed dorsoventrally with preatrium distinct; dorsal apodeme absent, shaft heavily sclerotized from base to anteapical origin of paired shaft processes, the more distal portion of shaft lightly sclerotized; processes slender extending basad, appressed to shaft, acute at tips. Sternal abdominal apodemes traversing two conjunctivae.

Ground color of crown and pronotum dull sordid yellow to dull gray, occasionally with a pair of dull orange markings on pronotal disc. Scutellum gray, the midline paler in basal half. Forewings milky subhyaline, a vitta in clavus parallel to claval suture and one in corium in brachial cell, dull yellow; apex of clavus, a spot in apex of brachial cell, apex of cell R, one in apex of cell M and one in each base of second and third apical cells, smoky. Face sordid yellow with a pair of darker vittae on clypeus; remainder of venter without dark markings.

Male holotype and 43 male paratypes, Rio Caraguata, Mato Grosso, Brazil, March 1953 (F. Plaumann), allotype, and 35 female paratypes in Snow Entomological Collections, University of Kansas; 8 paratypes in U. S. National Museum. One additional specimen from Los Cruces, Panama, and one from Trinidad Naval Base, B. W. I., have been examined.

The long recurved aedeagal processes are not found in other species of *Balera*.

***Balera pusilla*, new species**

FIGURE 13,*a–d*

Length of male 3.3 mm. Crown short, triangular with apex subangulate; median length about two-thirds interocular width and about half median length of pronotum which is about as wide as head including eyes, with lateral margins slightly divergent posteriorly. Male plates with macrosetae in double row near base of plate, uniseriate in apical two-thirds, decreasing in size apically, the row extending to the plate apex. Pygofer produced slightly dorsad apically in a broadly rounded lobe. Anal process short. Style not greatly exceeding apex of connective, with preapical lobe distinct, apical extension strongly decurved. Connective triangular with a median keel apically. Aedeagus slender and elongate, preatrium distinct, dorsal apodeme distinct, shaft with a median ventral and paired lateral anteapical keels, the ventral keel produced posteriorly beneath gonopore in a spiniform apical process. Sternal abdominal apodemes as in *B. caraguatae*.

Crown and pronotum greenish yellow, a darker yellow spot on each side of pronotum in posterior part of disc. Scutellum sordid yellow, the transverse sulcus bordered with ivory. Forewing hyaline with a faint green stripe in clavus and a similar stripe in brachial cell of corium; costal margin bordered with green in its basal third; a faint smoky spot in claval apex, in apices of cells M and Cu and in bases of each of inner three apical cells; wing apex tinted with smoky. Face and venter sordid unmarked greenish yellow.

Holotype male from Las Palmas, Veraguas Province, Panama, Sept. 16, 1953; three paratypes from Aguadulce, Coclé Province,

Panama, Sept. 25, 1951; and one paratype each from Chiriquí, Chiriquí Province, Panama; Paris, Herrera Province, Panama; Río Hato, Coclé Province, Panama; and Fort Kobbe, Panama Canal Zone, all collected by F. S. Blanton and in U. S. National Museum (No. 62675).

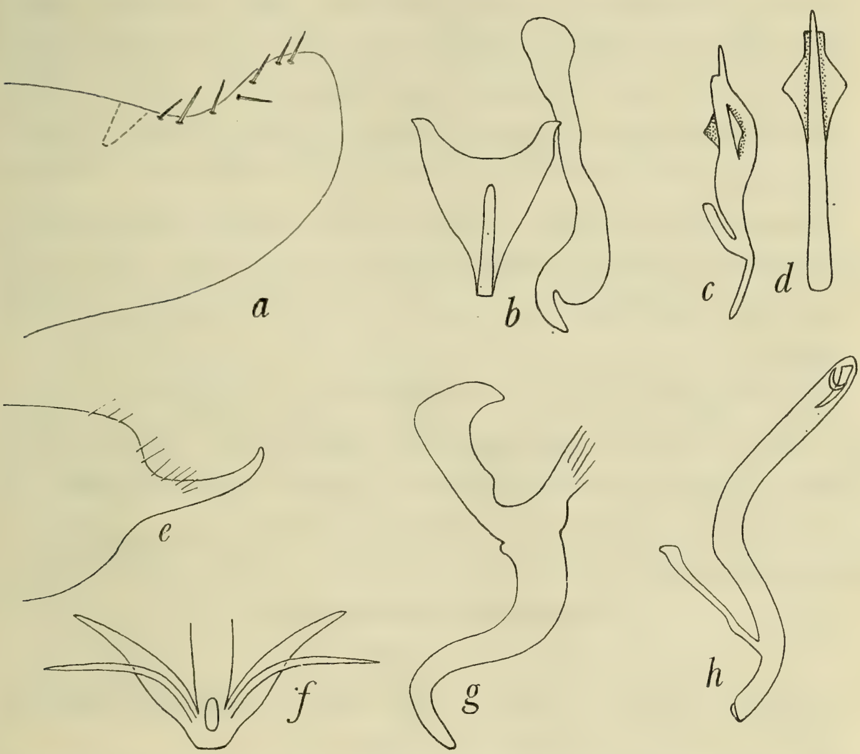

FIGURE 13.—*Balera.* *a–d*, *B. pusilla* (type): *a*, pygofer, lateral aspect; *b*, style, and connective, dorsal aspect; *c*, aedeagus, lateral aspect; *d*, aedeagus, caudal aspect. *e–h*, *B. emarginata*: *e*, pygofer, lateral aspect; *f*, apex of aedeagus, dorsal aspect; *g*, style, lateral aspect; *h*, aedeagus, lateral aspect.

The male genitalia will readily distinguish this from other species of *Balera.*

Balera emarginata (Osborn)

FIGURE 13,*e–h*

Empoasca emarginata Osborn, Ann. Carnegie Mus., vol. 18, p. 286, 1928.

Length of male 3.6 mm. Crown short, very slightly produced, median length slightly less than interocular width and more than half of pronotum which is narrower than head including eyes. Male plates each with single row of macrosetae extending from basal fourth

almost to apex. Pygofer with midposterior margin produced posteriorly in gradually tapering process which is curved sharply dorsad at apex, the tip sharply rounded; in ventral aspect the two processes slightly convergent. Style short and slender, strongly sigmoid, the apex directed ventrad, with few small preapical setae along ventral surface. Connective Y-shaped. Aedeagus with preatrium short; dorsal apodeme elongate, slender; shaft extending caudodorsad in basal portion, curved and directed caudad in greater portion of its length, with a pair of flattened lateral processes and pair of dorsal cylindrical processes at apex; gonopore oval, preapical, dorsal. Sternal abdominal apodemes not capitate, traversing one abdominal conjunctiva.

Ground color of crown, pronotum and scutellum straw yellow. Forewing pale milky translucent, base of costa, entire clavus, and brachial cell faintly yellow, with a faint fumose spot in apex of brachial cell; apical veins contrasting paler. Face and venter entirely pale yellow.

The type and a short series of paratypes from Bolivia are in the Carnegie Museum and are the only specimens known. As stated by Osborn in the original description, the type series appears to be faded. The above color description is from a topotypic male, not determined by Osborn, in the Carnegie Museum.

The male genitalia will readily separate this species from other species of *Balera.*

Genus *Brunerella* Young

FIGURE 14

Brunerella Young, Univ. Kansas Sci. Bull. 35, p. 31, 1952 (type *Brunerella magnifica* Young by original designation).

Hind wing with submarginal vein distinct apically, close to apical wing margin, extending slightly basad of apex of vein M_{1+2} as a short spur; posterior branch of R occurring as a long spur; vein Cu_2 confluent with submarginal vein at point proximad of vein m-cu. Forewing with appendix not extending around apex which is smoothly rounded; inner apical cell slender, parallel-sided; second apical cell slender, length half or more length of inner apical cell, parallel-sided; third apical cell sessile, slightly broader at apex than at base; outer apical cell much longer than broad, its base distinctly proximad of base of third apical cell. Female seventh sternum more than twice length of sixth, posterior margin broadly produced medially; pygofer with numerous irregular pale macrosetae on posterior two-thirds its length. Male plates short, gradually tapered, scarcely exceeding posterior pygofer margin, each with a longitudinal row of pale discal macrosetae extending from near base almost to apex. Male pygofer

not strongly produced, with a vertical group of few macrosetae on disc, without processes but with differentially sclerotized rods in pygofer wall. Anal processes present, short. Style short, slightly expanded anteapically; basal portion occasionally with plate-like lobe extending beneath articulating portion of connective. Connective slender, shallowly V-shaped. Aedeagus with preatrium short, broad; atrium with a pair of lateral apodemes arising from its dorsal portion; shaft slender, without processes or ornamentation. Sternal abdominal apodemes vestigial.

Head short, crown transverse with anterior margin very broadly rounded, with median length more than one-third greater than interocular width; ocelli on broadly rounded margin between crown and face, closer to inner eye margins than to median line of head. Pronotum short, broad, its width equal to width of head including eyes, lateral margins divergent posteriorly. Face broadly convex.

Distribution: Cuba and Mexico.

In both of the species treated below, the ventral face of the style is produced, plate-like, in a lobe that extends mesad beneath the articulation of the style. In males of *magnifica* the lobe is clearly defined and has the appearance of a branch of the style. In the allotype of *scriptozona* the lobe is less extensive and much less clearly defined at its apex.

In a recent paper, Linnavuori (1954, p. 132) placed *Typhlocyba flavonigra* Stål in this genus, and illustrated the type, a female from Brazil. In general form and venation of the forewing the resemblance to the species treated below is close. The venation of the apex of the hind wing differs. No males of the Stål species are known.

Key to species of *Brunerella*

Forewing with a broad deep red angular marking in base of clavus, second apical cell usually about two-thirds length of first; male pygofer with posterodorsal margin slightly emarginate . . . . **magnifica** Young

Forewing with a narrow pink marking in base of clavus, second apical cell about half length of first; male pygofer not emarginate posterodorsally. **scriptozona** (Van Duzee)

Brunerella magnifica Young

FIGURE 14,*a–f*

Brunerella magnifica Young, Univ. Kansas Sci. Bull. 35, p. 32, 1952.

Length of male 3.3–3.5 mm. Crown with median length about one-half greater than interocular width and two-thirds median length of pronotum. Forewing with length of second apical cell variable, usually more than half length of inner apical cell. Male pygofer with posterior margin slightly concave. Style with distinct ventral

lobe extending mesocaudad beneath articulation with connective. Aedeagus in ventral aspect with shaft narrowest at midlength, in lateral aspect with apical fifth curved abruptly caudodorsad.

Head with crown ivory white with an irregular orange V-shaped mark in center, the arms broadly touching eyes. Pronotum sanguineous, posterior margin slate-gray, with a dark border between red and gray portions laterally. Scutellum greenish yellow, a slender dark transverse line just before apex. Forewing pruinose with a pale brick-red streak along costa near base, an angulate broad sanguineous vitta, its apex directed mesad, in basal half of clavus, and a contiguous red spot in adjacent corium, the posterior margin of both narrowly edged in black; apical half of clavus except extreme tip and inner half of adjacent corium amber, the corial portion continuing caudad, becoming fumose, and broadening to cover apical cells except few slate-gray fenestrae and brick-red apical veins; base of outer apical cell fumose next costal margin. Face and legs ivory, hind tibia narrowly embrowned apically. Female pygofer black with pale setae.

In specimens from Cuba, the red color of the anterior portion of the pronotum invades the more posterior gray portion in a large median tooth that extends nearly to the hind margin of the pronotum, and the darker coloration between red and gray areas is deeper than in the typical variety described above. The angular red markings of the anterior part of the forewing are deeper red and more extensive, forming a deep red line across the basal fourth of wing except hyaline areas, one adjoining scutellum, and one astride claval suture. The amber yellow of the central part of the wings extends completely across both wings nearly as far distad as the apex of the clavus. The wing apices are more deeply dark and the dark markings extend cephalad to include the claval apex.

The holotype, a male from Mexico near Jalapa, is in the Snow Entomological Collections. A series of Cuban specimens from Almandares River, near Havana, is in the U. S. National Museum.

Brunerella scriptozona **(Van Duzee), new combination**

FIGURE 14,*g–k*

Protalebra scriptozona Van Duzee, Proc. California Acad. Sci., ser. 4, vol. 12, p. 186, 1923.

Length of both sexes (to apex of hind wing) 3.0 mm. Crown with median length more than one-half greater than interocular width and about four-fifths median length of pronotum. Forewing with second apical cell slightly more than half length of inner apical cell. Male genitalia as in *B. magnifica* Young, but pygofer not distinctly concave along posterodorsal margin, aedeagal shaft not broadened anteapically in ventral aspect, more gradually curved dorsocaudad in

apical half in lateral aspect, and style with basal plate-like lobe much less pronounced.

Crown dull ivory, in some specimens with a pair of faint yellow oblique vittae on disc. Pronotum pale gray, two angular spots on anterior margin and two similar spots near humeral margins, pink. Forewing with ground color lacteus, basal fourth with an angular vitta in base of clavus connected posteriorly with an undulate line extending

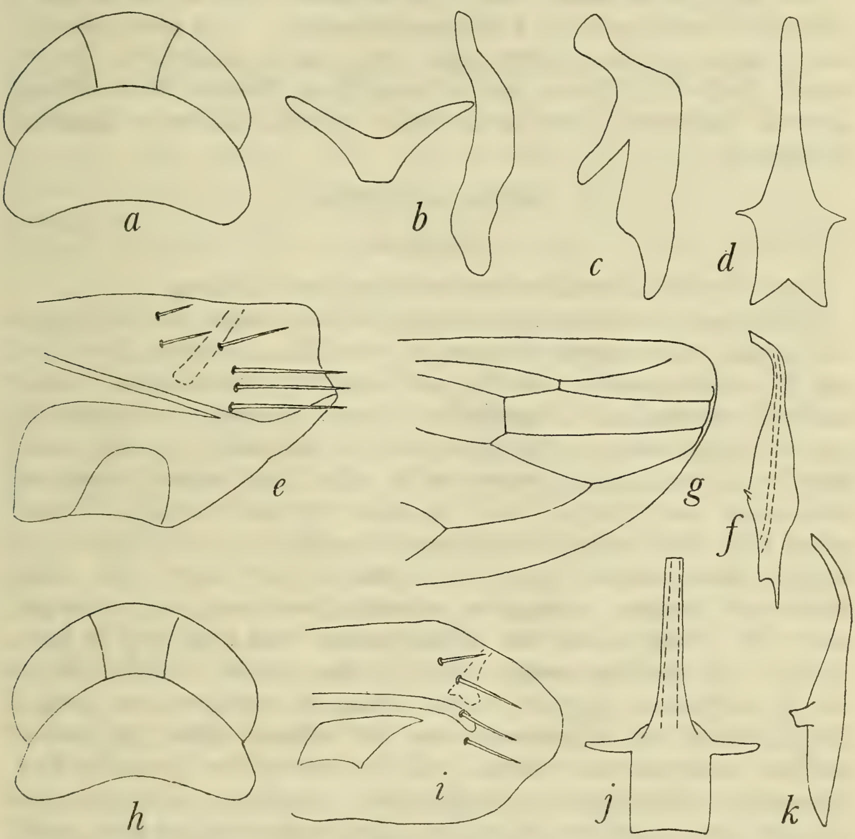

FIGURE 14.—*Brunerella.* *a–f*, *B. magnifica:* *a*, anterior dorsum; *b*, style and connective, dorsal aspect; *c*, style, ventrolateral aspect; *d*, aedeagus, ventral aspect; *e*, pygofer, lateral aspect (broken line is anal process); *f*, aedeagus, lateral aspect. *g–k*, *B. scriptozona* (allotype): *g*, apex of hind wing (in situ); *h*, anterior dorsum; *i*, pygofer, lateral aspect (broken line is anal process); *j*, aedeagus, ventral aspect; *k*, aedeagus, lateral aspect.

from commissural margin into corium, pale red; middle three-fifths of clavus and most of adjoining corium pale yellow, a spot in claval apex, one in apex of brachial cell, a longitudinal mark in base of appendix, a narrow diagonal line across midlength of inner apical cell, a narrow transverse arcuate line across basal halves of second and third apical

cells and a broad transverse band across wing apex from appendix to inner half of third apical cell, smoky; veins bordering apices of cells R and M and bases of second and third apical cells, crimson. Mesosterna black in both sexes. Female with face and remainder of venter pale gray except pygofer which has darker markings dorsally and laterally; abdomen black dorsally. Male face and venter as in female, but venter of abdomen black.

The holotype, a female from Ceralbo Island, Gulf of California, is in the California Academy of Sciences collections. The above description is based on the allotype male, from Puerto Ballandra, Carmen Island, Gulf of California, and a female from Espíritu Santo Island, Gulf of California. Both were loaned by the California Academy of Sciences.

Lareba, new genus

FIGURE 15

Type of genus, *Protalebra variata* Ruppel and DeLong.

Hind wing with submarginal vein distinct at apex but contiguous with apical wing margin to apex of vein M_{1+2}; posterior branch of vein R entire apically; vein Cu_2 confluent with submarginal vein at midlength of wing, much basad of vein m-cu. Forewing with appendix not extending around wing apex which is smoothly rounded; inner apical cell broad basally, narrower in apical half; second apical cell broader at apex than at base, less than two-thirds length of inner apical cell; third apical cell triangular; outer apical cell wider than long, its base distinctly proximad of base of third apical cell. Male plates very elongate, triangular, exceeding posterior pygofer margin, each with a longitudinal row of macrosetae from near base to apex. Pygofer with posterior margin produced, disc with an irregular oblique row of macrosetae; pygofer process arising on posteroventral margin. Ninth tergum with a transverse bar but without delimiting lines of flection. Anal processes absent. Style elongate without preapical lobe. Connective relatively short, papilioniform. Aedeagus with preatrium distinct, dorsal apodeme strap-like, slightly expanded at apex; shaft laterally compressed, appearing bifurcate in lateral aspect, the dorsal ramus bearing the gonoduct. Head short and broad, the anterior and posterior margins of crown parallel; ocelli on very broadly rounded margin between crown and face, about midway between inner eye margins and median line of head. Pronotum slightly wider than head including eyes; lateral margins slightly divergent posteriorly. Face in profile with contour strongly divergent from line of crown.

Known only from the genotype, from Mexico.

The relationship of *Lareba* to other alebrine genera is not clear. Among the broad-headed forms with a sclerotized connective, it is

distinct from *Balera* and *Brunerella* in its elongate styles, possession of pygofer processes and the venation of the forewings; and from *Balera* additionally in its possession of discal macrosetae on the pygofer. The bifurcate aedeagus in *Lareba* also differs from the genera mentioned above, and is very similar to that found in *Diceratalebra* but this feature is believed to be polyphyletic.

Lareba variata (Ruppel and DeLong), new combination

FIGURE 15

Protalebra variata Ruppel and DeLong, Ohio Journ. Sci., vol. 53, p. 226, 1953.

Length of male 3.5 mm. Crown with anterior margin broadly rounded, with median length approximately two-thirds interocular width and less than half length of pronotum. Pygofer process sickle-shaped, the two processes widely separated apically in ventral aspect. Styles half length of male plates, gradually tapered, slightly decurved

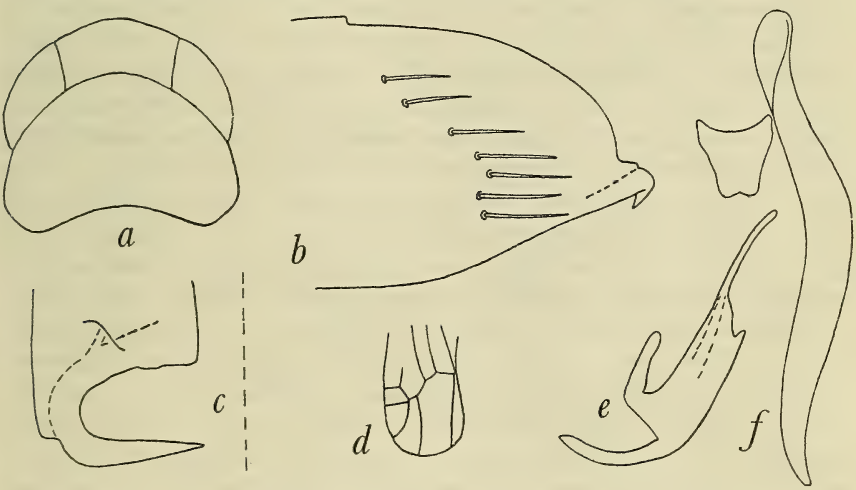

FIGURE 15.—*Lareba variata:* *a*, anterior dorsum; *b*, pygofer, lateral aspect; *c*, pygofer process, ventral aspect (midline broken); *d*, apex of forewing; *e*, aedeagus, lateral aspect; *f*, style and connective, dorsal aspect.

and acute apically. Aedeagus with preatrium and dorsal apodeme subequal in length; shaft with ventral ramus very short. Sternal apodemes broad, short, not traversing one conjunctiva.

Crown ivory with a pair of distinct black spots on anterior portion of disc. Pronotum with anterior two-thirds yellow suffused with orange; posterior third ivory. Scutellum and ground color of forewings yellow, a spot across claval suture near base, a transverse transcommissural vitta bordered with black anteriorly, crossing midclavus

and extending through brachial cell and into cell M in each wing, a small spot at midlength of clavus, apices of cells R and M, outer apical cell and bases of first, second, and third apical cells hyaline; an oblique stripe extending from just behind midcosta to claval apex, thence bordering basal veins of inner three apical cells, and apices of inner three apical cells, smoky. Face and venter pale.

The holotype, a male from Cutzamala, Guerrero, Mexico, has been examined from the DeLong collection. The species is known only from Guerrero.

Lawsonellus, new genus

Figure 16

Type of the genus, *Dikraneura attenuata* Osborn.

Hind wing with submarginal vein distinct at apex but forming a part of apical wing margin to apex of vein M_{1+2}; posterior branch of vein R entire apically; vein Cu_2 confluent with submarginal vein at point considerably proximad of vein m-cu. Forewing with appendix not extending around apex which is smoothly rounded; inner apical cell broadened gradually towards apex; second apical cell short, less than half length of inner apical cell, parallel-sided; third apical cell sessile; outer apical cell longer than broad, not attaining apical wing margin, its base distinctly proximad of base of third apical cell. Male plates elongate, triangular, attaining posterior pygofer margin, each with a single row of macrosetae extending from near base almost to apex. Pygofer very strongly produced; macrosetae numerous and irregularly arranged; pygofer processes absent. Ninth tergum with an elongate membranous area along middorsum. Anal processes absent. Style short, without preapical lobe. Connective T-shaped, the unpaired portion directed cephalad. Aedeagus with preatrium greatly elongate, longer than shaft; dorsal apodeme simple, short, strap-like; shaft bisinuate, broader at base, with an elongate unpaired aciculate ventral process appearing as a continuation of the long preatrium. Head strongly produced; ocelli on rounded margin between crown and face, closer to inner margins of eyes than to median line of head. Pronotum wider than head including eyes; lateral margins slightly divergent posteriorly. Face flat in profile.

Known only from the genotype, from Bolivia. This genus is dedicated to the late Dean Paul B. Lawson of Kansas University, who contributed much to our knowledge of Homoptera through both his own efforts and his encouragement of his associates.

In 1952 (loc. cit.), with poor material at hand, I placed this species in *Elabra* because the form of the head and the venation of the forewings were similar to other species of that genus. Subsequent study of a perfect male from the Stettin Natural History Museum reveals

so many differences—the bizarre aedeagus, the T-shaped connective, the shorter male plates relative to the pygofer, the absence of pygofer processes—that it is deemed advisable to erect a separate genus for the above species. The unpaired ventral aedeagal process suggests a relationship with *Habralebra*, but in other characters the species of that genus are quite distinct.

Lawsonellus attenuatus (Osborn), new combination

FIGURE 16

Dikraneura attenuata Osborn, Ann. Carnegie Mus., vol. 18, p. 269, 1928.
Dikraneura albidula Osborn, op. cit., p. 271.
Elabra attenuata; Young, Univ. Kansas Sci. Bull. 35, p. 35, 1952.

Length of male 3.7 mm. Crown with median length more than twice interocular width, and slightly greater than median length of pronotum. Male genitalia as in generic description. Sternal abdominal apodemes short, not traversing one conjunctiva.

Crown, pronotum, and scutellum ivory, with a broad median sordid yellow vitta on crown expanded posteriorly and continuing over pronotum to its hind margin, the lateral margins suffused with orange on the pronotum. Forewings yellowish translucent with a poorly delimited deeper yellow tint along commissure to claval apex in each

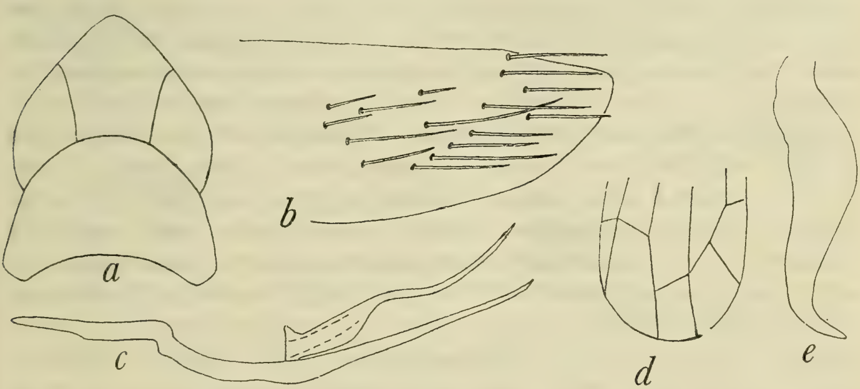

FIGURE 16.—*Lawsonellus attenuatus: a,* anterior dorsum (type); *b,* pygofer, lateral aspect (type); *c,* aedeagus, lateral aspect; *d,* apex of forewing; *e,* apical portion of style, lateral aspect.

wing and a similar marking in corium parallel to costal margin from base to midlength of wing; second apical cell with a yellow cloud in base. Face and venter pale.

Known only from the type, the type of the synonym, both in Car-

negie Museum, and a male specimen in the Stettin Natural History Museum, all from Bolivia.

Genus *Habralebra* Young

FIGURES 17–20

Habralebra Young, Univ. Kansas Sci. Bull. 35, p. 33, 1952 (type *Protalebra nicaraguensis* Baker by original designation).

Hind wing with submarginal vein almost or completely confluent with apical wing margin to apex of vein M_{1+2}; posterior branch of vein R nearly always evanescent apically; vein Cu_2 confluent with submarginal vein at point considerably proximad of vein m-cu. Forewing with appendix not extending around apex which is smoothly rounded; inner apical cell almost parallel-sided; second apical cell less than two-thirds length of inner apical cell (exception: *H. bifasciatella*, new species); third apical cell sessile; outer apical cell triangular, its base opposite to or very slightly basad of base of third apical cell. Male plates elongate-triangular, attaining or slightly exceeding posterior pygofer margin, each narrowed in apical half with longitudinal row of macrosetae on middle half, apex lobate and turned dorsad. Pygofer with posterior margin produced or rounded, disc with single vertical row of macrosetae; a process usually arising near conjunctiva dorsally. extending ventrad; ventral margin rolled mesad and often giving rise to a process which is directed caudad. Ninth tergum with a transverse bar-like or triangular tergite which is almost always delimited laterally by a line of flection. Anal processes present or absent. Style with or without preapical lobe. Aedeagus with dorsal apodeme usually well developed, Y- or T-shaped; atrium giving rise to large ventral unpaired atrial process (absent in *bifasciata* (Gillette)) that is usually thicker (exceptions: *willinki*, new species, and *terminalis* (Osborn)) than apical half of long tapering shaft. Head produced with apex rounded; crown with median length exceeding interocular width; ocelli on rounded margin between crown and face, about equidistant from inner eye margins and median line of head. Pronotum longer than crown, wider than head including eyes, lateral margins strongly divergent posteriorly. Face slightly convex in lateral aspect. Color pale, with golden reflections, usually with black or orange markings.

Distribution: West Indies, Central America, and South America.

The relationship of *Habralebra* to the other alebrine genera is problematical. Considering *H. alliodorae* (Caldwell and Martorell) alone, the almost bifurcate aedeagal shaft, the chaetotaxy of the pygofer, the form of the ventral pygofer processes, and the absence of a preapical lobe in the style, are suggestive of *Diceratalebra*, but *alliodorae* is undoubtedly much more closely related to the other species of

Habralebra included here. These stand as a group well apart from all other genera in the characteristic venation of the forewings, form of the aedeagus, bright golden color marked with black or orange, and apart from *Diceratalebra* particularly in the additional characters of the dorsal aedeagal apodeme (not elongate, as in *Diceratalebra*) and the tubular form of the aedeagal shaft, which is laterally compressed in *Diceratalebra*.

The holotype of *Protalebra transversalis* Baker (Invertebrata Pacifica, vol. 1, p. 6, 1903), a female, has been examined and it appears to belong in this genus. Males are needed from the type locality, Acapulco, Mexico, to establish its identity.

Key to species of *Habralebra*

1. Aedeagus with unpaired ventral process wanting . . . **bifasciata** (Gillette)
   Aedeagus with unpaired ventral process present 2
2. Aedeagal process less than half length of shaft 3
   Aedeagal process more than half length of shaft 4
3. Aedeagal process vestigial, occurring as a minute tooth; pygofer process in lateral aspect exceeding posterior pygofer margin; style with apical extension weakly curved . . . . **terminalis** (Osborn)
   Aedeagal process pronounced; pygofer process in lateral aspect not attaining posterior pygofer margin; style with apical extension strongly curved. **trimaculata** (Gillette)
4. Aedeagus with unpaired ventral process elongate-setiform, narrower than shaft measured at midlength . . . . **willinki,** new species
   Aedeagus with unpaired ventral process long or short, not setiform, broader than shaft measured at midlength 5
5. Aedeagal shaft in ventral aspect with apical portion appearing cruciate. **cruciata,** new species
   Aedeagal shaft not so 6
6. Pygofer without ventral processes 7
   Pygofer with distinct ventral processes 9
7. Style with apical extension broadly expanded at apex 8
   Style with apical extension not expanded at apex. **bifasciatella,** new species
8. Aedeagus with preatrium elongate; ventral aedeagal process with width at midlength distinctly less than twice width of shaft in lateral aspect, long, slender and gradually tapering . . . . **gillettei,** new species
   Aedeagus with preatrium wanting; ventral aedeagal process with width at midlength distinctly greater than twice width of shaft in lateral aspect, short, broad, abruptly tapered at apex . . . . . . **williamsi,** new species
9. Pygofer with ventral process exceeding posterior pygofer margin, decurved. **alliodorae** (Caldwell and Martorell)
   Pygofer with ventral process not attaining posterior pygofer margin, not decurved 10
10. Style with apical extension gradually tapered at apex; pygofer process elongate in lateral aspect; dorsal aedeagal apodeme Y-shaped with very short arms 11

Style with apical extension abruptly rounded at apex; pygofer process very short in lateral aspect; dorsal aedeagal apodeme Y-shaped with very long arms . . . . **amoena** (Baker)

11. Aedeagus with shaft gently curved; connective trapezoidal; ventral pygofer process doubly right-angled in ventral aspect . . **panamensis,** new species

Aedeagus with shaft straight; connective Y-shaped; ventral pygofer process more smoothly curved in ventral aspect . . . . . **nicaraguensis** (Baker)

Habralebra nicaraguensis (Baker)

Figure 17,*a–f*

Protalebra nicaraguensis Baker, Invertebrata Pacifica, vol. 1, p. 6, 1903.
Habralebra nicaraguensis; Young, Univ. Kansas Sci. Bull. 35, p. 34. 1952.

Length of male 3.1 mm. Crown with median length slightly more than one-third greater than interocular width and three-fourths median length of pronotum. Male pygofer with posterodorsal margin produced posteriorly and rounded apically; ventral pygofer process in lateral aspect extending caudodorsad, not attaining pygofer margin, gradually tapered from base to apex; in ventral aspect the two ventral processes subparallel, each process with a lateral anteapical lobe and a slender curved tapering apical portion; dorsal pygofer margin thickened and giving off a slender differentially sclerotized integumental bar directed anteroventrad to middle of pygofer disc. Ninth tergum with a distinct narrow transverse tergite. Anal processes absent. Style without distinct preapical lobe, slightly broadened at midlength. Connective Y-shaped. Aedeagus with preatrium distinct; dorsal apodeme well developed, Y-shaped, the arms short and broad; atrium giving off an unpaired broad falcate process conspicuously thicker than apical half of shaft, extending dorsad almost as far as shaft; shaft straight. Sternal abdominal apodemes not traversing one conjunctiva.

Crown and pronotum ivory suffused with yellow. Scutellum brown, a pair of longitudinal lines before transverse sulcus, and the anteapical portion, black; apex and two anteapical marginal spots ivory. Forewing yellowish translucent with a smoky longitudinal vitta along commissure in basal half of clavus, the marking expanded laterally towards claval suture at apex; apex of clavus and of adjoining brachial cell, basal half of inner apical cell and base of second apical cell smoky, forming an hourglass-shaped pattern on the wings in repose; wing apices smoky. Face and venter pale yellow.

The holotype, a female from San Marcos, Nicaragua, is in the Pomona College collection. The above description is based on a male specimen, from Mexico, in the collection of D. M. DeLong.

Habralebra panamensis, new species

FIGURE 17,*g–j*

Length of male 3.0–3.1 mm., of female 3.2 mm. Proportions of head and pronotum as in *H. nicaraguensis* (Baker). Female seventh sternum with caudolateral angles broadly rounded, posterior margin transverse; pygofer heavily setose with all of setae pale. Male pygofer with posterior margin slightly produced dorsally and subtruncate; ventral pygofer process much as in *nicaraguensis* in lateral aspect; in ventral aspect curved abruptly mesad, then abruptly caudad, each curve through 90°; dorsal thickening of pygofer wall as in *nicaraguensis* but with the ventral portion digitiform, not acute apically. Ninth tergite as in *nicaraguensis*. Anal processes submembranous. Style as in *nicaraguensis* but with apex more rounded. Connective trapezoidal. Aedeagus as in *nicaraguensis*, but with shaft gently curved caudad throughout its length and exceeding the unpaired ventral process in length. Sternal abdominal apodemes traversing one conjunctiva.

Color variable. Crown and pronotum ivory suffused with orange. Scutellum varying from orange marked with black (type) as in *nicaraguensis*, to orange yellow with an anteapical dark spot, or pale yellow with basal angles gray (allotype). Forewings varying from the design in *nicaraguensis* but with the transcommissural claval marking hourglass-shaped and deeper hued than the more posterior similarly shaped marking (type) to a design where the more anterior transcommissural marking is orange except a black apical portion, or (allotype) a design in which the anterior marking is reduced to a dark spot in base of corium and a narrow transverse line at midclavus. Face and venter pale yellow.

Holotype male, allotype female, and one male paratype from Mindi Dairy, Panama Canal Zone, Dec. 3, 1951 (F. S. Blanton) are in U. S. National Museum (No. 62677).

H. panamensis is very closely related to *nicaraguensis* from which it may be most readily distinguished by the characters in the key, above.

Habralebra williamsi, new species

FIGURE 17,*k–n*

Length of male 3.8 mm. Crown with median length about one-fourth greater than interocular width and two-thirds median length of pronotum. Male pygofer with posterior margin subtruncate, posterodorsal and posteroventral margins rounded; ventral pygofer process bisinuate, in ventral aspect with basal portion longer and

directed caudad, apical portion directed mesad thence caudad; with one dorsal pygofer process as in *panamensis*, and a second process consisting of a barlike integumental thickening extending from near base caudoventrad to middle of disc. Ninth tergite as in *nicaraguensis* Anal process very short, truncate apically. Style with distinct

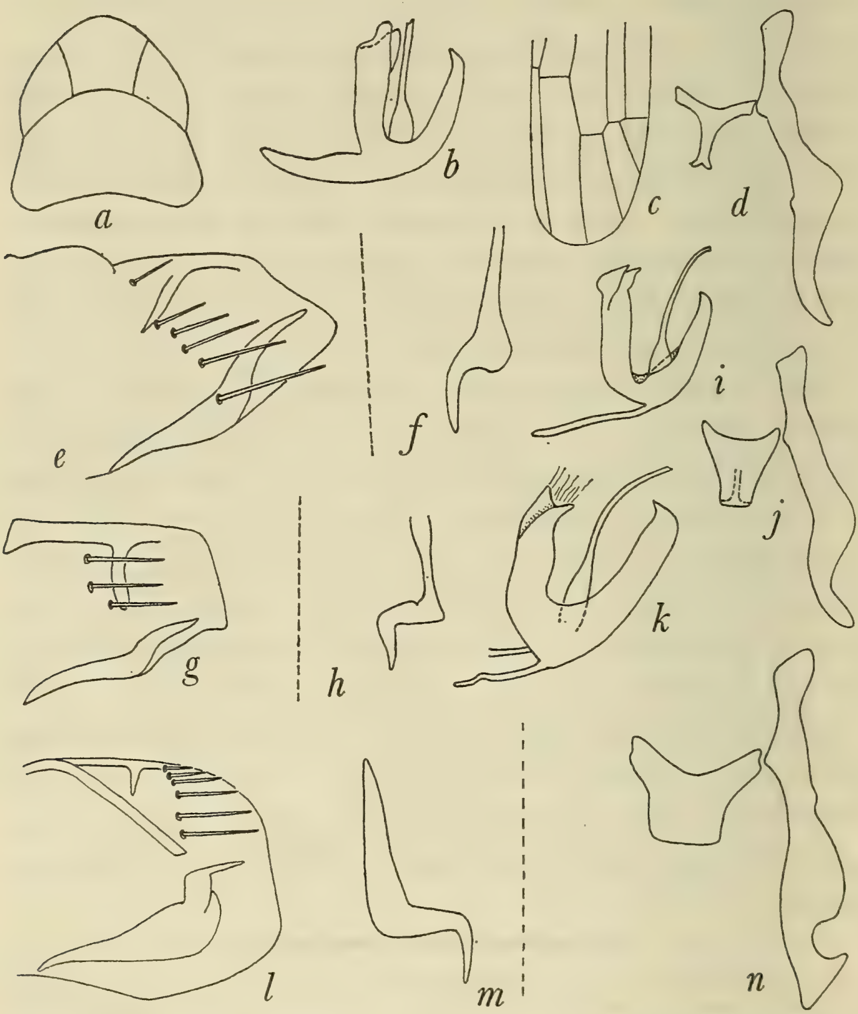

FIGURE 17.—*Habralebra*. *a–f*, *H. nicaraguensis*: *a*, anterior dorsum; *b*, aedeagus, lateral aspect; *c*, apex of forewing; *d*, style and connective, dorsal aspect; *e*, pygofer, lateral aspect; *f*, pygofer process, ventral aspect. *g–j*, *H. panamensis*: *g*, pygofer, lateral aspect; *h*, pygofer process, ventral aspect; *i*, aedeagus, lateral aspect; *j*, style and connective, dorsal aspect; *k–n*, *H. williamsi* (type): *k*, aedeagus, lateral aspect; *l*, pygofer, lateral aspect; *m*, pygofer process, ventral aspect; *n*, style and connective, dorsal aspect. (In *f*, *h*, and *m* the broken lines represent the midventral line of the specimen.)

preapical lobe and with apical extension strongly expanded apically, the apical margin obliquely truncate. Connective short Y-shaped, the unpaired portion broad. Aedeagus similar to that of *panamensis*, but with ventral process broader and longer.

Crown and pronotum dull orange, the latter with a pale spot along each anterolateral margin. Scutellum black except dull yellow basal angles and anteapical short transverse vitta, extreme apex ivory. Forewings golden hyaline, each with a broad transverse marking across midlength of clavus from claval suture to commissure and a conspicuous dot near base of corium, black; a broad marking along each commissure from claval apex to base of second apical cell, forming with its counterpart on opposite wing an hourglass-shaped dark smoky pattern; apical cells pale smoky except a narrow paler area separating the apical area from the darker area more cephalad. Face dull gray except a paler median vitta, remainder of venter pale.

Holotype male, Tena, Ecuador, Mar. 29, 1923 (F. X. Williams), in collection of the Hawaiian Sugar Planters Association.

From *panamensis* and *nicaraguensis* to which it is closely related, *williamsi* is readily distinguished by its expanded style apex and externally by the conspicuous black dot in the base of the corium of the forewing. The dot is very small in *panamensis*, absent in *nicaraguensis*.

Habralebra alliodorae (Caldwell and Martorell), new combination

FIGURE 18,*a–d*

Protalebra alliodorae Caldwell and Martorell, Journ. Agr. Univ. Puerto Rico, vol 35, p. 88, 1952.

Length of male 2.9 mm. Crown with median length one-third greater than interocular width and four-fifths median length of pronotum. Female seventh sternum with lateral angles rounded, posterior margin transverse, slightly emarginate at middle; pygofer with few elongate pale macrosetae. Male pygofer in lateral aspect with posterior margin broadly rounded; ventral pygofer process strongly arched, the apex directed caudoventrad, exceeding posterior pygofer margin, in ventral aspect smoothly curved mesad then caudolaterad; with an additional barlike integumental thickening arising on disc near base extending caudoventrad beyond middle of disc. Ninth tergum with a distinct triangular tergite delimited by lines of flection. Anal processes absent. Style slender, gradually tapered, without a distinct preapical lobe, apex acute and slightly decurved. Connective a transverse bar. Aedeagus with preatrium distinct, dorsal apodeme elongate, T-shaped; shaft broad in basal half, apical half much narrower, arcuate, curving gradually caudad, with ventral process short, cultrate, curved strongly towards shaft.

Crown and pronotum dull gray, forewings hyaline with two transverse dark bands, the more anterior including the scutellum and basal third of the clavus, the more posterior in breadth extending from apex of clavus to midlength of inner apical cell, extending laterad, narrowing rapidly on anterior margin from middle of cell M to very narrow extremity on costal margin. Venter entirely pale.

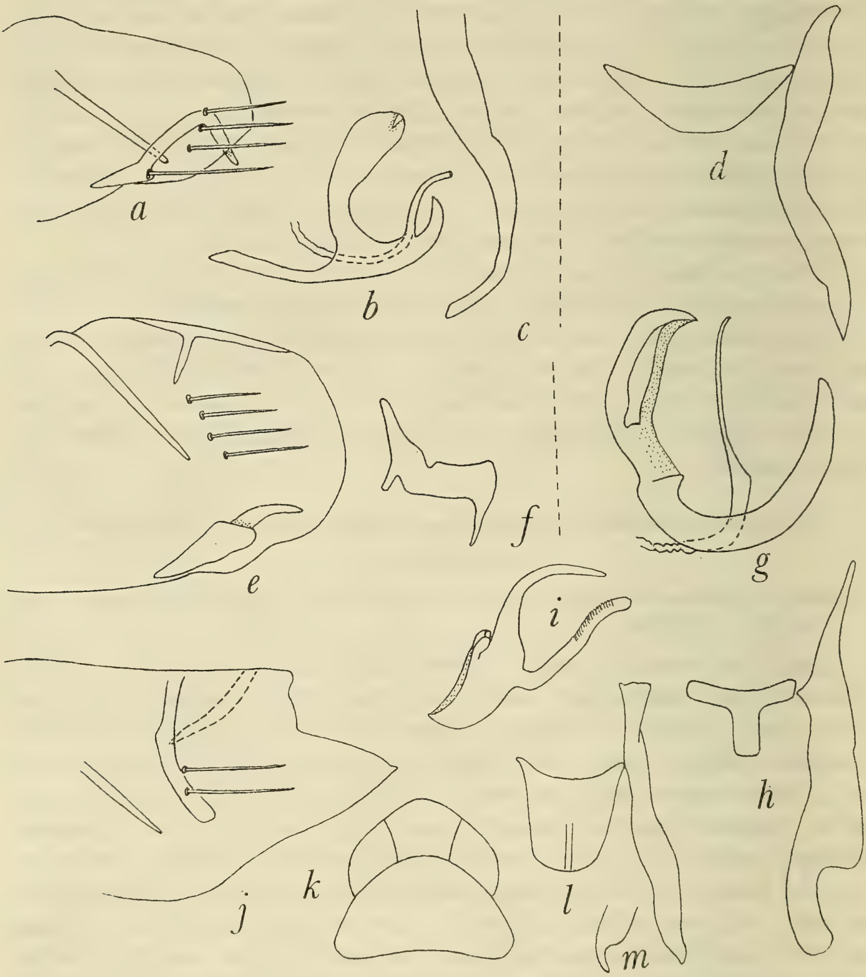

FIGURE 18.—*Habralebra*. *a–d*, *H. alliodorae*: *a*, pygofer, lateral aspect; *b*, aedeagus, lateral aspect; *c*, pygofer process, ventral aspect; *d*, style and connective, dorsal aspect. *e–h*, *H. amoena* (type): *e*, pygofer, lateral aspect; *f*, pygofer process, ventral aspect; *g*, aedeagus, lateral aspect; *h*, style and connective, dorsal aspect. *i–m*, *H. bifasciatella* (type): *i*, aedeagus, lateral aspect; *j*, pygofer, lateral aspect; *k*, anterior dorsum; *l*, style and connective, dorsal aspect; *m*, style apex, lateral aspect. (In figures *c* and *f* the midventral line is broken.)

The holotype, a male from Río Piedras, Puerto Rico, is in the U. S. National Museum. A specimen has also been examined from Cayamas, Cuba.

From the foregoing three species, to which it is closely related, *alliodorae* may be easily separated by its longer ventral pygofer process, and its very distinct aedeagus which differs in that the shaft and the unpaired ventral process are fused through approximately half the length of the former.

Habralebra amoena (Baker)

FIGURE 18,*e–h*

Protalebra amoena Baker, Psyche, vol. 8, p. 404, 1899.
Habralebra amoena; Young, Univ. Kansas Sci. Bull. 35, p. 34, 1952.

Length of male 3.5 mm. Crown with median length one-third greater than interocular width and three-fourths median length of pronotum. Male pygofer broadly rounded apically; ventral pygofer process short, not attaining posterior pygofer margin, with an apical beak directed caudad, other pygofer processes as in *H. williamsi* Young. Ninth tergite as in *H. nicaraguensis* (Baker). Anal processes absent. Style elongate with distinct preapical lobe, apical extension rounded at tip. Connective Y-shaped, the unpaired portion short. Aedeagus with preatrium absent; dorsal apodeme elongate Y-shaped; shaft abruptly narrowed on posterior margin near base, apical two-thirds slender, directed dorsad and very slightly caudad; unpaired ventral process stout, crescentiform, not attaining apex of shaft. Sternal abdominal apodemes very short, not traversing one conjunctiva.

Ground color of crown and pronotum golden yellow, crown with discal area washed pale orange, pronotum with discal area bright orange. Ground color of scutellum ivory, the basal angles buff, a narrow anteapical transverse band black. Forewing hyaline, a small black dot in corium near base, an irregular vitta adjoining commissure in basal half of clavus, orange; an indistinct vitta in brachial cell extending abruptly mesad through apical half of clavus to commissure, pale orange; an inverted C-shaped mark beginning at apex of brachial cell, extending along commissure in basal half of inner apical cell, then laterad into base of second apical cell, smoky; apical portions of first and second apical cells broadly smoky. Venter completely pale, the face and pleural portion of pronotum ivory.

This species is known only from the type, a male, from Chapada, Brazil, in the U. S. National Museum.

The style apex, with its preapical lobe and apical extension not broadened at apex, and the aedeagal shaft, narrowed on the posterior margin near base, will serve to separate *amoena* from the foregoing species of *Habralebra*.

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Habralebra bifasciatella, new species

FIGURE 18,*i–m*

Length of male 2.7 mm. Crown with medium length one-sixth greater than interocular width and two-thirds median length of pronotum. Forewing with second apical cell measured along inner margin more than two-thirds length of inner apical cell measured along its outer margin. Male pygofer with posterior margin strongly produced in a triangular lobe; ventral pygofer processes absent; disc with very few macrosetae in vertical row; dorsal margin giving off a slightly curved digitate process on each side, each process extending caudoventrad slightly beyond middle of disc and free from pygofer wall in cephalic aspect; a short aciculate diagonal process consisting of thickened integument near center of disc. Ninth tergite as in *H. nicaraguensis* (Baker). Anal process distinct, slender, acute apically, not attaining middle of pygofer disc. Style slender, elongate, with small preapical lobe and short decurved apical extension. Connective semi-ovate. Aedeagus with preatrium wanting; dorsal apodeme transverse; shaft gradually tapered, regularly arched, the apex curved ventrad; ventral unpaired process digitiform, exceeding shaft in length, rugose anteapically. Sternal abdominal apodemes not traversing one conjunctiva.

Crown dull yellow. Pronotum golden. Scutellum fumose with a small median basal yellow spot, the area on each side of the transverse sulcus and extreme apex, dull yellow. Forewing golden translucent with a broad smoky band across basal third of clavus extending into corium, and a broad, slightly paler band across appendix and bases of apical cells, becoming narrower at costal margin. Face and venter stramineous.

Holotype male, Mojinga Swamp, near Fort Sherman, Panama Canal Zone (F. S. Blanton), in U. S. National Museum (No. 62678).

From the preceding species of *Habralebra*, *bifasciatella* is easily distinguished by its lack of a ventral pygofer process.

Habralebra willinki, new species

FIGURE 19,*a–e*

Length of male 3.3 mm. Crown with median length almost one-third greater than interocular width and two-thirds median length of pronotum. Female seventh sternum more than twice length of sixth, with lateral margins produced and rounded to hind margin which appears as a shallow emargination; pygofer heavily setose on posterior two-thirds, with all of setae pale. Male pygofer with posterior margin slightly produced at midlength, the apex rounded; ventral pygofer process short, slightly sinuous, extending caudomesad, not attaining midventral line; dorsal pygofer process

and ninth tergite as in *H. nicaraguensis* (Baker). Anal process slender, truncate apically, not reaching middle of disc of pygofer. Style with distinct preapical lobe, apical extension not strongly broadened at apex, decurved, with a small preapical tooth on dorsal face. Connective triangular. Aedeagus with preatrium wanting; dorsal apodeme well developed with an anteroventrad-directed lobe and a pair of short lobes directed dorsad; shaft elongate, broader on basal portion, narrower and slightly arched caudodorsad in apical half; ventral process slender, aciculate, much shorter than shaft. Sternal abdominal apodemes not traversing one conjunctiva.

Ground color of crown and pronotum golden yellow, the anterolateral portions of pronotum paler. Scutellum with ground color ivory, basal angles golden, margined internally with dark, a preapical transverse marking black. Forewings transparent with golden reflections, a transverse vitta across commissure in basal third of clavus, evanescent anteriorly, becoming darker posteriorly, not attaining claval suture of either wing; inner anteapical portions of wings with dark margins in form of hourglass, apical cells faintly fumose. Venter entirely pale.

Holotyle male, Ledesma, Jujuy Province, Argentina, Feb. 10, 1950 (A. Willink and F. Monrós), in collection of Miguel Lillo Foundation, Tucumán, Argentina.

A female specimen from Nova Teutonia, Brazil, is in the Snow Entomological Collections, University of Kansas.

This species differs from all others in the genus in the slender setiform unpaired ventral process of the aedeagus.

Habralebra trimaculata (Gillette)

FIGURE 19,*g–i*

Alebra trimaculata Gillette, Proc. U. S. Nat. Mus., vol. 20, p. 712, 1898.
Habralebra trimaculata; Young, Univ. Kansas Sci. Bull. 35, p. 34, 1952.

Length of female 3.5 mm. Crown with median length one-third greater than interocular width, and two-thirds median length of pronotum. Female seventh sternum very large, more than three times length of sixth sternum, posterolateral portions broadly rounded, posterior margin gradually and very slightly produced and rounded at middle; pygofer with numerous irregularly arranged pale macrosetae over apical two-thirds. Male pygofer in lateral aspect with ventral pygofer process short, having pronounced lateral lobe, apical portion slender, curved gradually posterolaterad, acute apically; with dorsal and oblique discal processes as in *H. williamsi* Young. Ninth tergite as in *H. nicaraguensis* (Baker). Anal processes arcuate, acute apically, not attaining middle of pygofer disc. Style elongate, with distinct preapical lobe and apical extension curved laterad, apex quadrate.

Connective triangular. Aedeagus with preatrium distinct; dorsal apodeme Y-shaped, the unpaired portion elongate; ventral process short, broad, not half length of shaft which is broader in basal half, slender, and slightly arched posterodorsad in apical half. Sternal abdominal apodemes not traversing one conjunctiva.

Crown, pronotum, and scutellum golden yellow tinged with ivory. Forewing transparent with golden reflections at base, along claval suture and along basal portion of costal margin; a commissural spot at apex of basal third of clavus and an oval one at apex of clavus, extending into brachial cell, black, a transverse spot through inner apical cell at midlength, extending into basal portion of second apical cell, smoky. Venter entirely pale except dark tarsal claws.

This species is known only from the type, a female, from Chapada, Brazil, in the U. S. National Museum, and a male from Ledesma, Jujuy Province, Argentina, in the collection of the Miguel Lillo Foundation, Tucumán, Argentina. It is not certain that the sexes are correctly associated, but the male agrees with the type in almost every detail.

The distinct but short unpaired aedeagal process, less than half the length of the shaft, will separate *trimaculata* from other species of *Habralebra*.

Habralebra terminalis (Osborn)

FIGURE 19,*j–n*

Alebra terminalis Osborn, Ann. Carnegie Mus., vol. 15, p. 451, 1924.

Length of male 3.6 mm. Crown with median length subequal to interocular width, and one-half median length of pronotum. Male pygofer with ventral portion of posterior margin produced and rounded; ventral pygofer process acute apically, exceeding posterior pygofer margin, arched in ventral aspect, the two processes appearing like reversed parentheses. Style not greatly exceeding connective in length, with preapical lobe distinct. Connective large, Y-shaped with unpaired portion very short. Aedeagus with preatrium short, dorsal apodeme small, shaft smoothly curved caudad, gradually tapered, with a minute denticle near its base on ventral surface. Sternal abdominal apodemes short, not exceeding two conjunctivae.

Ground color of crown yellowish ivory, a pair of discal spots deeper yellow. Pronotum golden with three submarginal oval ivory spots near anterior margin. Scutellum golden yellow with basal angles dull yellow and transverse sulcus broadly bordered behind with ivory. Forewing hyaline with indefinite yellow suffusions outlining paler areas from wing base to claval apex; apical portions of first and second apical cells, and base of second apical cell, smoky. Face and venter dull yellow.

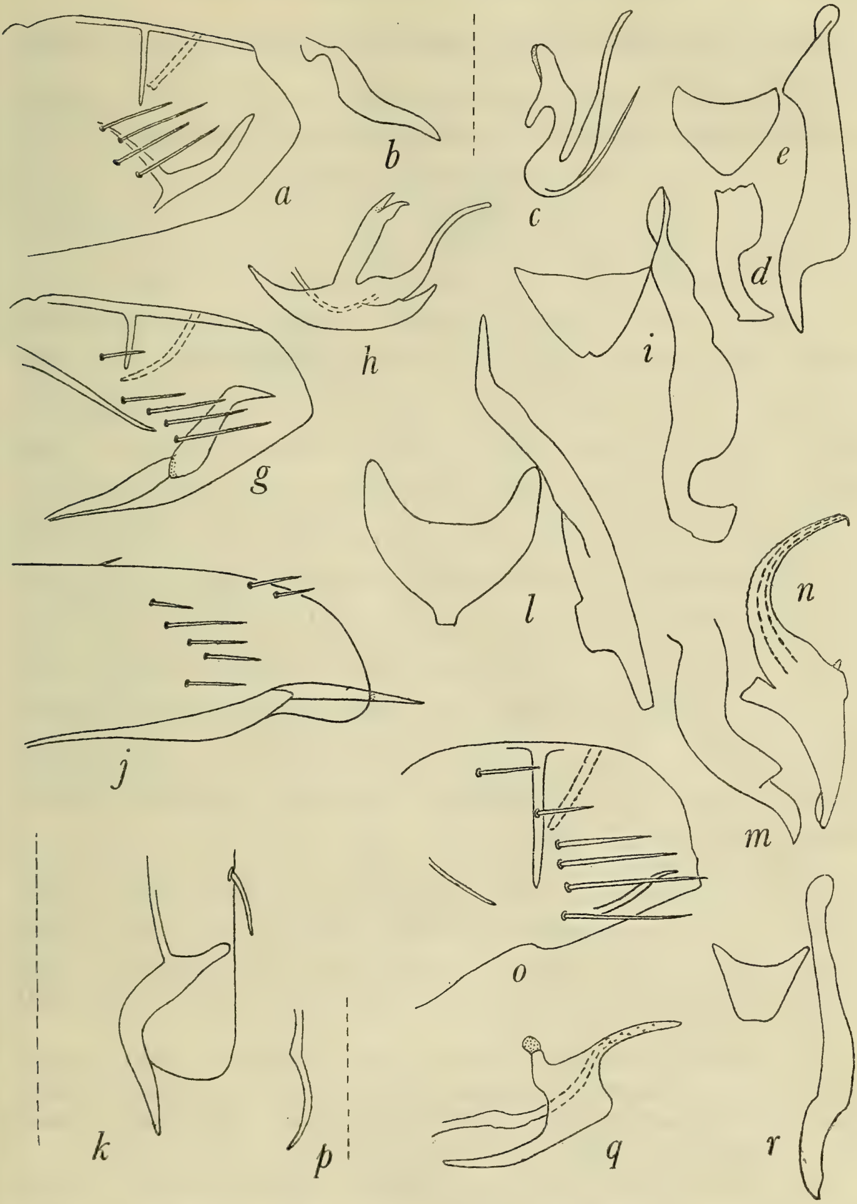

Figure 19.—*Habralebra.* *a–e*, *H. willinki:* *a*, pygofer, lateral aspect (broken line is anal process); *b*, pygofer process, ventral aspect; *c*, aedeagus, lateral aspect; *d*, style apex, lateral aspect; *e*, style and connective, ventral aspect. *g–i*, *H. trimaculata:* *g*, pygofer, lateral aspect (broken line is anal process); *h*, aedeagus, lateral aspect; *i*, style and connective, dorsal aspect. *j–n*, *H. terminalis* (type): *j*, pygofer, lateral aspect; *k*, left side of pygofer, ventral aspect; *l*, style and connective, dorsal aspect; *m*, style apex, lateral aspect; *n*, aedeagus, lateral aspect. *o–r*, *H. bifasciata* (type): *o*, pygofer, lateral aspect (broken line is anal process); *p*, pygofer process, ventral aspect; *q*, aedeagus, lateral aspect; *r*, style and connective, dorsal aspect. (In *b*, *k*, and *p* the midline of the specimen is represented by a broken line.)

Known only from the type, a male from Bolivia, in the Carnegie Museum.

This species, in the vestigial toothlike unpaired ventral aedeagal process, differs drastically from other species of *Habralebra*.

Habralebra bifasciata (Gillette)

FIGURE 19,*o–r*

Alebra bifasciata Gillette, Proc. U. S. Nat. Mus., vol. 20, p. 711, 1898.
Habralebra bifasciata; Young, Univ. Kansas Sci. Bull. 35, p. 34, 1953.

Length of male 3.3 mm., of female 3.5 mm. Crown with median length approximately one-sixth greater than interocular width and about three-fourths median length of pronotum. Female seventh sternum more than twice length of sixth, hind margin produced and broadly rounded; pygofer setae as in *H. trimaculata* (Gillette). Male pygofer in lateral aspect with posterodorsal margin broadly rounded, posteroventral margin forming an almost right-angled lobe; ventral pygofer process short, acute apically, the two processes shaped like reversed parentheses; dorsal pygofer process extending ventrad past middle of pygofer disc; with an anterior oblique barlike process before middle of disc. Ninth tergum with triangular tergite. Anal processes weak. Style slender and elongate, without distinct preapical lobe. Connective broadly U-shaped. Aedeagus with preatrium elongate, dorsal apodeme short, Y-shaped, the arms widespread, shaft slender, short, gradually decurved, provided with dispersed minute basally-directed projections, ventral process rudimentary, occurring as short, broad rounded projection.

Entirely pale yellow except two broad transverse brownish black stripes on dorsum, one across basal portion of forewings and entire scutellum, its hind margin traversing clavus at about apex of basal third length of latter; the other across anteapical portion of forewings, over apex of clavus and basal half of inner apical cell, abruptly narrowed at costal extremity.

This species is known only from the male type and a female paratype in the U. S. National Museum. Both were collected in Chapada, Brazil; the former in April, the latter in August. The other specimens in the type series belong to another species.

The complete absence of an unpaired ventral aedeagal process serves to set this species apart from others in the genus.

Habralebra gillettei, new species

FIGURE 20,*a–c*

Alebra bifasciata (part.) Gillette, Proc. U. S. Nat. Mus., vol. 20, p. 711, 1898.

Length of male 3.2–3.5 mm., of female 3.3–3.5 mm. Crown with median length slightly greater than interocular width and three-

fourths median length of pronotum. Female seventh sternum with a broad median keel ending posteriorly in a blunt tooth; lateral margins produced posteriorly, each into a distinct rounded lobe; pygofer setae as in *H. panamensis* Young. Male pygofer in lateral aspect with posterodorsal portion slightly produced in a short lobe; ventral pygofer process wanting; dorsal process extending ventrad beyond middle of pygofer disc; disc with a short barlike integumental

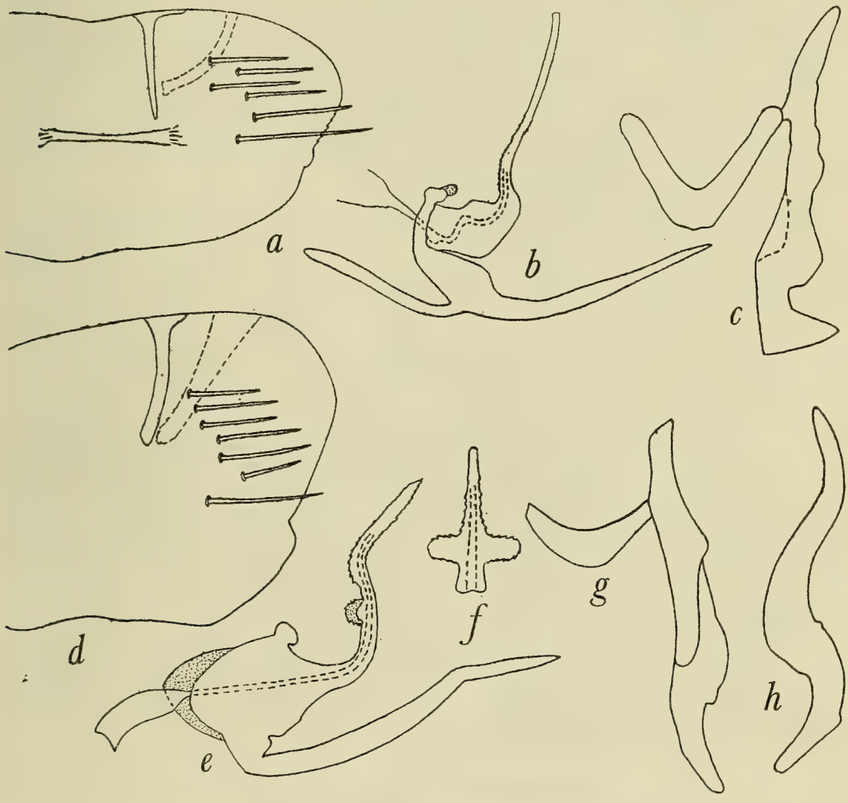

FIGURE 20.—*Habralebra.* *a–c*, *H. gillettei* (type): *a*, pygofer, lateral aspect; *b*, aedeagus, lateral aspect; *c*, style and connective, dorsal aspect. *d–h*, *H. cruciata: d*, pygofer, lateral aspect; *e*, aedeagus, lateral aspect; *f*, apex of aedeagus, caudal aspect; *g*, style and connective, dorsal aspect; *h*, style, lateral aspect. (In *a* and *d* the broken line represents the anal process.)

thickening. Ninth tergite as in *H. nicaraguensis* (Baker). Anal process as in *H. bifasciatella* Young. Style short, with distinct preapical lobe and with short foot-shaped apical extension that is variable apically, either with apical margin broadly convex or shallowly concave (type). Connective V-shaped. Aedeagus with preatrium elongate, dorsal apodeme short T-shaped, shaft broad in

basal third, slenderly cylindrical in apical two-thirds; unpaired ventral process strongly divergent from shaft, expanded basally, gradually tapered to acute apex. Sternal abdominal apodemes very short, not traversing one conjunctiva.

Ground color of crown and pronotum pale yellow to sordid orange. Scutellum, except pale yellow to white basal angles and median basal spot, black, apex ivory. Forewings translucent lacteus to transparent, each with basal third of clavus, an adjoining dot on corium (occasionally absent), a small spot near costal margin in basal third, and a large blotch along commissural margin extending from apex of clavus to midlength of inner apical cell and from commissure to base of outer cell, black, the apical blotches of the forewings in repose shaped like an hourglass. Venter entirely pale, the discal portion of the face occasionally slightly darker.

Holotype male (USNM 62679) from Chapada, Brazil, April, and paratype male, same data (both misdetermined paratypes of *Alebra bifasciata* Gillette), in U. S. National Museum; paratype male from Campinas, Brazil, in Pomona College collection; numerous male paratypes from Rio Caraguata, Mato Grosso, Brazil, March 1952 (F. Plaumann), in U. S. National Museum and in Snow Entomological Collections; female paratypes from Salta Province, Argentina, Jan. 9, 1949 (M. Aczel), and Ledesma, Jujuy Province, Argentina, Feb. 10, 1950 (A. Willink and F. Monrós), and two male paratypes from Salta Province, Argentina, Jan. 31, 1950 (R. Golbach) in collection of Miguel Lillo Foundation, Tucumán, Argentina; and one male paratype from Provincia del Sara, Bolivia, in Stettin Natural History Museum.

This species is closely related to *cruciata* but differs in the expanded apex of the style and the aedeagal shaft which lacks the transverse expansion found in *cruciata*. The more anterior transcommissural marking of the forewings is orange in *cruciata*.

***Habralebra cruciata*, new species**

FIGURE 20,*d–h*

Length of male 3.5 mm. Crown with length about one-fourth greater than interocular width and about two-thirds median length of pronotum. Male pygofer with posterior margin broadly rounded, weakly bilobate; ventral and discal processes absent; dorsal process as in *H. gillettei* Young but not attaining middle of disc of pygofer. Ninth tergite occurring as a transverse rod, not delimited by a line of flection laterally. Anal processes submembranous. Style elongate, with weak preapical lobe and with apical extension gradually curved ventrad, its dorsal surface with a small protuberance near midlength; style apex rounded. Connective shallowly U-shaped.

Aedeagus with preatrium wanting, atrium with lateral margins flared cephalolaterad; dorsal apodeme very short T-shaped; shaft bisinuous with a pair of auriculiform appendages near midlength, the shaft appearing cruciate in caudal aspect; ventral aedeagal process as long as shaft, abruptly curved caudad before apex. Sternal abdominal apodemes traversing two conjunctivae.

Ground color of crown and pronotum pale yellow, a broad pink spot on disc of pronotum. Scutellum with basal angles dull yellow, the intervening area brown, apical half ivory, a transverse anteapical stripe and a pair of triangles, one on each side before middle of lateral margin, black. Forewings hyaline, a large transcommissural brick-red spot across claval bases, its hind margin bordered with black; apical cells, except outermost, fumose, the darker area extending cephalad into claval apex, apex of brachial cell and adjacent portion of cell M; an indistinct streak along basal portion of costal margin and a similar area in brachial cell, golden yellow. Venter entirely pale.

Holotype male, Campinas, Brazil, in Pomona College collection.

***Omegalebra*, new genus**

Figures 21–23

Type of the genus, *Protalebra vexillifera* Baker.

Hind wing with submarginal vein usually confluent with apical wing margin; posterior branch of vein R evanescent apically; vein Cu_2 confluent with submarginal vein at point much proximad of vein m-cu. Forewing with appendix not extending around wing apex which is smoothly rounded; inner apical cell broader at base than at apex; second apical cell usually parallel-sided, its length measured along inner margin two-thirds or more length of inner apical cell measured along the common margin; third apical cell stalked; outer apical cell longer than broad, not attaining apical wing margin; cells R and M with anteapical widths about equal; color including a conspicuous omega-shaped marking (exception: *lenticula*). Female seventh sternum greatly produced posteriorly, in length equal to or greater than length of exposed portion of ovipositor in those species in which female is known; pygofer with numerous well dispersed pale macrosetae except near base, a few of these contrasting black in some species. Male plates elongate, triangular, at least attaining, usually exceeding, posterior pygofer margin, each with a longitudinal row of pale macrosetae which either extends full length of plate or occupies only the middle half, in some species with some of the setae contrasting black. Male pygofer with dispersed macrosetae, not in rows (exception: *ogloblini*); pygofer processes present, their origin variable interspecifically but not arising on dorsal pygofer margin. Ninth

tergum with a pair of dorsolateral lines of flection. Anal processes present or absent. Style with a distinct preapical lobe. Connective U-, V-, or Y-shaped, usually extending caudad one-half length of shaft or more. Aedeagus variable interspecifically. Head produced, triangular, crown with median length equal to or exceeding interocular width; ocelli on rounded margin between crown and face. Pronotum longer than crown, wider than head including eyes, lateral margins divergent posteriorly; posterior margin usually bisinuately concave, occasionally smoothly concave.

Distribution: West Indies, Central America, and South America.

In addition to the species included in the key below, *Protalebra omega* Van Duzee (Bull. Buffalo Soc. Nat. Sci., vol. 8, p. 75, 1907), described from females and of which additional females have been examined from Jamaica during this study, should be placed here.

The omega-shaped markings of the forewings are also found in *Protalebra* and *Paralebra*.

Key to species of *Omegalebra*

1. Aedeagus with a large ventral process which is forked apically and with a pair of processes arising at base of shaft . . . . **ogloblini,** new species.
   Aedeagus without such processes, occasionally with processes arising apically or anteapically on shaft 2
2. Aedeagus strongly arched in lateral aspect 3
   Aedeagus straight or very slightly curved, not strongly arched 4
3. Male pygofer process arising ventrally, unbranched; pygofer with posterodorsal portion not strongly produced; aedeagal shaft unarmed; length of male 3.2–3.3 mm.; anterior portion of omega-shaped marking completely bordered with black. . . . . **matogrossana,** new species
   Male pygofer process arising dorsally, bifurcate; pygofer with posterodorsal portion strongly produced; aedeagal shaft with a few retrorse anteapical teeth on dorsal margin; length of male 3.8–3.9 mm.; anterior margin of omega-shaped marking with black border interrupted medially.
   barbata, new species
4. Pygofer process arising ventrally, or apically and with a posteroventral thickening of pygofer wall; aedeagus with minute processes on shaft 5
   Pygofer processes arising apically and without posteroventral thickening of pygofer wall; aedeagus without processes 7
5. Aedeagal processes anteapical and lateral on shaft; connective thickly U-shaped . . . . **balloui,** new species
   Aedeagal process apical, laterally compressed; connective Y-shaped with unpaired portion thick. 6
6. Aedeagus with dorsal apodeme T-shaped, shaft undulate apically, the dorsal and ventral apical processes asymmetrical; posterior border of transverse portion of omega-shaped marking not red . . . . . **morrisoni,** new species
   Aedeagus with dorsal apodeme laterally compressed; shaft straight, the apical processes symmetrical, posterior border of transverse portion of omega-shaped marking red . . . . **blantoni,** new species

7. Pygofer with process bifurcate; dorsal aedeagal apodeme circular in caudal aspect; transverse portion of omega-shaped marking red-bordered posteriorly **vexillifera** (Baker)
   Not with above characters. 8
8. Pygofer process longer, arising as a thickening of posterodorsal pygofer margin; dorsal aedeagal apodeme saddle-shaped in lateral aspect; extreme apex of style not notched . . . . **lenticula** (Osborn)
   Pygofer process short, arising apically on the posterior pygofer margin, the margin not thickened; dorsal aedeagal apodeme not saddle-shaped in lateral aspect; extreme apex of style notched . . . . **cordiae** (Osborn)

Omegalebra vexillifera (Baker), new combination

FIGURE 21,*a–h*

Protalebra vexillifera Baker, Psyche, vol. 8, p. 404, 1899.

Length of male 3.4 mm. Crown with apex sharply rounded; median length approximately equal to interocular width. Pronotum with median length almost twice median length of crown; posterior margin smoothly or sinuately concave. Ocelli about midway between inner margins of eyes and median line of head.

Male plates gradually tapered, extending as far caudad as posterior pygofer margin, each with row of macrosetae from near base to apex. Pygofer with posterior margin broadly rounded; pygofer process arising on posterior pygofer margin, biramous, the ventral branch more elongate and extending mesad. Ninth tergite present, bounded laterally and apically by lines of flection. Anal processes short, weak, expanded apically, not attaining middle of pygofer disc. Style with foot-shaped apical extension. Connective Y-shaped, the unpaired portion broad, extending caudad more than half length of shank of style. Aedeagus with preatrium short, dorsal apodeme semicircular, shaft slender, short, nearly straight, without processes. Sternal abdominal apodemes traversing one conjunctiva.

Ground color of crown, pronotum and scutellum ivory, a V-shaped marking on anterior portion of pronotum, and a short submarginal vitta near and parallel to humeral margin on each side, pale orange; a marginal black spot on each side of scutellum and a preapical transverse stripe, black. Forewing with ground color pale yellowish translucent, with a conspicuous omega-shaped lacteus marking crossing commissure at scutellar apex on each wing, attaining costal wing margin opposite midclavus, thence extending along vein M to its apex thence directed laterad and ending in apex of cell R, the transverse portion bordered anteriorly with black, posteriorly with crimson; veins forming bases of apical cells pale, margined with dull yellow, the yellow coloration darkening laterally and becoming fumose and filling third apical cell. Face and venter pale except bases of post-

tibial spines and some of spines themselves, black. Pleural portion of pronotum pink.

Known from the type series, from Chapada, Brazil, in the U. S. National Museum.

Omegalebra lenticula (Osborn), new combination

FIGURE 21,*i–k*

Protalebra lenticula Osborn, Journ. Dep. Agr. Porto Rico, vol. 13, p. 103, 1929.

Length of both sexes 2.8–3.1 mm. Crown with apex obtusely rounded, median length slightly greater than interocular width. Pronotum with median length about one-third greater than median length of crown. Ocelli closer to median line than to eyes. Female pygofer without contrasting black macrosetae. Male plates exceeding apex of posterior pygofer margin, each with row of macrosetae from near base almost to apex. Male pygofer with ventral half of posterior margin produced posteriorly in short weak lobe; pygofer process arising along posterodorsal margin, extending ventrad, the apical half elongate-triangular, the apex extending ventrad slightly beyond ventral pygofer margin; macrosetae in irregular arrangement parallel to dorsal and posterior pygofer margin. Ninth tergite absent. Anal processes absent. Style short, with short curved apical extension which bears a protuberance near its base. Connective Y-shaped with unpaired portion short. Aedeagus with preatrium short, dorsal apodeme saddle-shaped in lateral aspect, slightly flattened on dorsal surface; shaft slender, almost straight, without processes. Sternal abdominal apodemes not attaining first conjunctiva.

Ground color of crown, pronotum and scutellum ivory; disc of crown with broad triradiate pale yellow to orange marking, its lateral arms attaining inner margins of eyes, its posterior arm attaining posterior margin of crown; pronotum with broad U-shaped similarly-colored marking extending from anterior margin to posterior half of disc, posterolateral angles yellow to orange; scutellum with basal angles yellow to ivory, transverse sulcus narrowly, a triangle on each lateral margin slightly basad of transverse sulcus and a broad anteapical transverse stripe, black. Forewings with omega-shaped marking obsolete, ground color whitish translucent, a transverse band, narrow at base of costal plaque, gradually broadened mesally and occupying basal third of clavus, fuscous posteriorly, abruptly fading anteriorly; apical half of clavus except tip, and adjacent corium pale yellow, the intervening claval suture contrastingly paler; a diagonal black vitta, interrupted on disc, extending from posterior margin of costal plaque caudomesad, becoming gradually

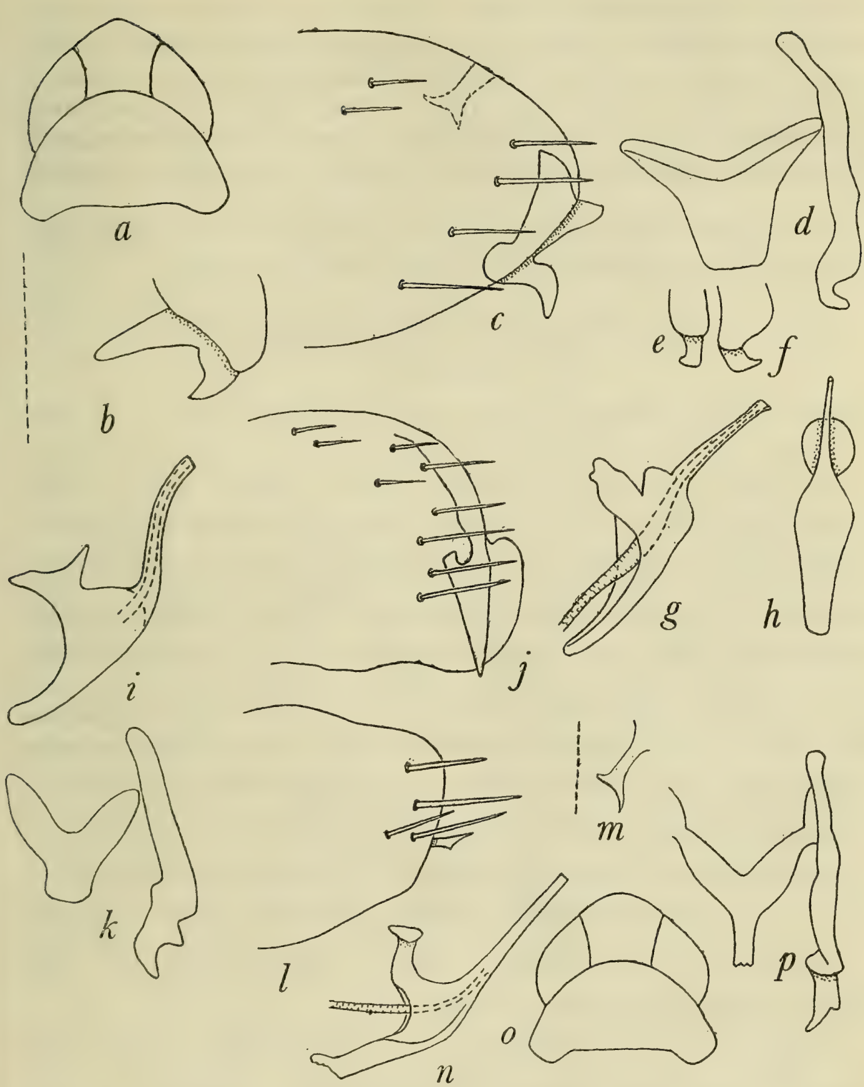

FIGURE 21.—*Omegalebra*. *a–h*, *O. vexillifera*: *a*, anterior dorsum; *b*, pygofer process, ventral aspect (broken line is midline of specimen); *c*, pygofer, lateral aspect; *d*, style and connective, ventral aspect; *e*, style apex, mesal aspect; *f*, same, caudal aspect; *g*, aedeagus, lateral aspect; *h*, aedeagus, ventral aspect. *i–k*, *O. lenticula*: *i*, aedeagus, lateral aspect; *j*, pygofer, lateral aspect; *k*, style and connective, dorsal aspect. *l–p*, *O. cordiae*: *l*, pygofer, lateral aspect; *m*, pygofer process, ventral aspect (broken line is midline of specimen); *n*, aedeagus, lateral aspect; *o* anterior dorsum; *p*, style and connective, dorsal aspect.

broader, to commissure in region of claval apex, thence caudolaterad along and outlining paler bases of second, third, and fourth apical cells to costal margin, thence gradually fading, extending parallel to and near apical wing margin, not attaining inner apical cell; inner apical cell weakly fumose in apical half. Ivory to pale yellow beneath, the pleural portion of the pronotum marked with orange to a variable degree.

This species is known only from Puerto Rico. The type is in the Herbert Osborn collection at the Ohio State University.

Omegalebra cordiae (Osborn), new combination

FIGURE 21,*l–p*

Protalebra cordiae Osborn, Journ. Dep. Agr. Porto Rico, vol. 13, p. 102, 1929.

Length of male 2.8 mm.; of female 2.7–3.0 mm. Crown with apex more broadly rounded than in *O. vexillifera* (Baker); median length one-fourth greater than interocular width. Pronotum with median length slightly greater than median length of crown. Ocelli about midway between inner eye margins and median line. Female seventh sternum as long as exposed portion of ovipositor; posterior margin angular but with apex truncate; pygofer with all macrosetae pale. Male plates exceeding posterior pygofer margin, each with row of macrosetae in middle half. Male pygofer in lateral aspect with posterodorsal portion slightly produced; with a posterodorsal submarginal group of few macrosetae; pygofer process arising near middle of hind margin, extending caudad, short, obliquely truncate apically in lateral aspect, bifid with short rami in ventral aspect. Ninth tergite as in *vexillifera*. Anal processes absent. Style with distinct preapical lobe and boot-shaped apical extension. Connective large, Y-shaped, extending caudad more than half length of shank of style. Aedeagus with preatrium well developed; dorsal apodeme T-shaped; shaft slender, straight, without processes.

Crown entirely dull yellow or dull yellow with ivory spots at base and apex. Pronotum dull yellow or ivory with diffuse yellow discal spots, humeral margins faintly pink. Scutellum yellow or ivory with a very narrow anteapical transverse black band. Forewings with ground color translucent yellow to hyaline, the chief marking a large omega-shaped design involving both wings, crossing commissural margins in their basal thirds, extending laterad on each wing to costal margin near its midlength thence mesocaudad to apex of cell M, thence slightly laterad to apex of cell R, contrasting bright yellow or lacteus, the transverse portion of the design bordered anteriorly with contrasting black, the longitudinal portions similarly bordered laterally, mesally and apically; occasionally with faint additional longi-

tudinal dark markings in basal and apical portions of clavus; apical half of brachial cell usually with a faint longitudinal dark vitta; veins at bases of apical cells black-bordered; apical portions of second, third and fourth apical cells darkly fumose. Face and venter pale except dark spots at base of posttibial spines and dark apices of posttibiae. Pleural portion of pronotum occasionally faint pink. Sternal abdominal apodemes attaining second conjunctiva.

The type, from Aguirre, Puerto Rico, is in the Ohio State University collection. Other specimens have been examined from Ponce and Cayey, Puerto Rico, from Vieques Island, and from St. Thomas, Virgin Islands. The host plant was reported to be *Cordia alliodora* by Martorell (*in* Caldwell and Martorell, 1952, p. 93).

Omegalebra blantoni, new species

FIGURE 22,*a–d*

Length of male 2.8–2.9 mm., of female 3.1 mm. Crown with apex broadly rounded; median length one-fourth greater than interocular width. Pronotum with median length approximately one-half greater than median length of crown; posterior margin shallowly, sinuately concave. Hind wing with submarginal vein not confluent with wing apex. Ocelli closer to eyes than to median line of head. Female seventh sternum as long as exposed portion of ovipositor, truncate apically; pygofer with a few macrosetae contrasting black. Male plates exceeding posterior pygofer margin, each with a row of macrosetae, some of which are conspicuous and black, on middle half. Male pygofer with posterior margin broadly rounded, disc with few irregularly arranged macrosetae near dorsal portion of posterior margin; pygofer process arising along ventral pygofer margin, curved abruptly mesad thence caudomesad at apex, apical portion gradually tapered and acute. Ninth tergite absent. Anal processes as in *O. vexillifera* (Baker). Style as in *O. lenticula* (Osborn). Connective thick, V-shaped, extending caudad to point opposite midlength of shank of style. Aedeagus with preatrium short; dorsal apodeme laterally compressed; shaft elongate, slender, with laterally compressed flange at apex. Sternal abdominal apodemes traversing one conjunctiva.

Ground color of crown, pronotum and scutellum ivory; crown with a transverse discal orange or gray marking extending from eye to eye, and a pair of gray spots anteriorly; pronotum with a Y- (type) or V-shaped dull orange marking on anterior half of disc, humeral margins narrowly red; scutellum as in *vexillifera*. Forewing with ground color dull yellow, markings as in *vexillifera*. Face, venter and pleural portion of pronotum as in *vexillifera* but with antennal bases orange.

Holotype male, Tocumen, Panamá Province, Panama, July 1, 1953 (F. S. Blanton), in U. S. National Museum (No. 62680), paratypes from Fort Clayton, Mojinga Swamp, and Mindi Dairy, Panama Canal Zone, and from El Retiro and Río Hato, Coclé Province, Panama.

O. blantoni is similar to *balloui*, new species, in the form of the pygofer and its processes and in the form of the style, and to *morrisoni*, new species, in the last feature and in the form of the aedeagal shaft. From *balloui*, *blantoni* may be separated by its laterally compressed aedeagal apex and distinct aedeagal apodeme; from *morrisoni* by the form of the pygofer processes (see illustrations) and the characters mentioned in the key.

This species is named for its collector, who collected the type series and whose extensive collections in Panama have provided material for a greater understanding of the Western Hemisphere leafhopper fauna.

Omegalebra balloui, new species

FIGURE 22,*e–i*

Length of female 3.3 mm. Female with apex of crown rounded; median length approximately one-fifth greater than interocular width. Pronotum of female with median length one-half greater than median length of crown; posterior margin shallowly, sinuately concave. Ocelli as in *O. vexillifera* (Baker). Female seventh sternum as long as exposed portion of ovipositor, posterior margin strongly produced with an apical subquadrate lobe; pygofer without contrasting black macrosetae. Male plates gradually tapering, exceeding posterior pygofer margin, each with a row of macrosetae on middle half. Male pygofer with posterior margin broadly rounded, posterior portion of disc with few irregularly arranged macrosetae; pygofer process arising along ventral margin, its free portion extending caudomesad from middle of posterior pygofer margin, short, slender, acute apically. Ninth tergite not differentiated. Anal process weak, almost attaining middle of pygofer disc. Style short, with preapical lobe strong, very short apical extension. Connective thickly U-shaped, extending distad almost as far as style apices. Aedeagus with preatrium distinct; dorsal apodeme wanting; shaft elongate, slender, with pair of anteapical processes which are rolled ventrad. Sternal abdominal apodemes traversing one conjunctiva.

Color, based on females: Ground color of crown, pronotum and scutellum dull yellow, crown with a faint spot at apex and one on each side on anterior margin, pronotum with a submarginal spot at middle of anterior margin, a faint longitudinal vitta on each side of disc and a transverse submarginal area at middle of posterior margin, dull ivory. Scutellum yellowish white, the basal angles yellow, a black spot at midlength of each lateral margin. Forewings with ground

color yellowish hyaline, the omega-shaped marking lacteus, crossing commissure in basal half of clavus, not contiguous with apex of scutellum, the transverse portion bordered anteriorly with black, the longitudinal portion partially bordered with black on outer and inner margins; each wing with cross veins mostly pale, bordered with smoky, third apical vein covered by a black mark which extends mesad along apical wing margin to inner apical cell. Face and venter pale, antennal bases and pleural portion of pronotum yellow, a spot at apex of posttibia and at apex of first hind tarsomere, black.

Holotype female and female paratype, San Pedro de Montes de Oca, Costa Rica, January 1937 (C. H. Ballou), in U. S. National Museum (No. 62681). The illustrations have been made from a topotypic male specimen represented only by wings and abdomen, the remainder having been lost from the cardboard point.

The relationships of this species are discussed under *blantoni*, above.

Omegalebra morrisoni, new species

Figure 22,*j–l*

Length of male 2.8 mm. Crown with apex sharply rounded; median length one-fourth greater than interocular width. Pronotum with median length one-third greater than median length of crown; posterior margin shallowly sinuately concave. Ocelli nearer to inner eye margins than to median line of crown. Male plates gradually tapered, exceeding posterior pygofer margin, each with row of macrosetae on middle half. Pygofer with posterior margin not produced, its posterodorsal portion shallowly emarginate; disc with sparse, irregularly arranged macrosetae on dorsal portion; pygofer process arising on posterior margin, short, stout extending mesad and ventrad, acute apically. Ninth tergite absent. Anal processes membranous. Style as in *O. blantoni* Young. Connective Y-shaped, unpaired portion broad. Aedeagus with preatrium distinct, dorsal apodeme T-shaped in cephalic aspect, apex expanded as in *blantoni* but not symmetrical as in that species.

Ground color of crown, pronotum and scutellum dull ivory; crown with a faint bilobed discal transverse orange vitta; pronotal markings as in *O. vexillifera* (Baker); scutellum with basal angles and an anteapical median marking pale yellow, a very narrow transverse anteapical stripe, black. Forewings with ground color gray, the apical two-thirds of claval suture and the omega-shaped marking hyaline, the latter crossing commissure in basal half of clavus, not contiguous to scutellum, its transverse portion narrowly bordered anteriorly with black with a pale orange more anterior border, bordered posteriorly with pale yellow, its longitudinal portions bordered with gray except for black border at costal margin of wing; cross veins, except black

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base of outer apical cell, pale, dark-margined, the wing apex black-margined from third apical cell to outer margin of apex of first apical cell; a fumose area near midlength of first and second apical cells.

Holotype male, "Duarte, Santo Domingo City, Republic of Dominica, July 21, 1917" (Harold W. Morrison), in U. S. National Museum (No. 62682).

The relationships of *morrisoni* are discussed above, under *blantoni*. This species is dedicated to its collector, who has collected many leafhoppers in the Caribbean area and who has made major contributions to homopterous taxonomy.

Omegalebra ogloblini, new species

FIGURE 22,*m–q*

Length of male 3.5 mm. Similar to *O. vexillifera* (Baker) in all gross features except anterior margin of crown which is more rounded in dorsal aspect. Male plates slightly exceeding posterior pygofer margin, each with row of macrosetae over middle half. Pygofer with posterodorsal portion produced posteriorly and emarginate at apex, with an oblique row of macrosetae on posterior portion of disc and two additional submarginal ones near base of dorsal margin; pygofer process arising at apex from an elongate horizontal integumental thickening over disc, extending caudomesad, short, slightly sinuate, gradually tapered. Ninth tergite absent. Anal processes strong, cultrate. Anterior margin of ninth tergum with a pair of conspicuous, anteriorly directed apodemes. Style with short, decurved apical extension. Connective V-shaped with a pair of small apical dorsal lobes. Aedeagus with preatrium short, dorsal apodeme trilobate; shaft inconspicuous, straight, simple-tubular, extending posterodorsad, with a pair of minute, lateral processes and with a single large ventral process which is gradually tapered and curved dorsad to the apex which is bifid, the branches approximate. Sternal abdominal apodemes traversing one conjunctiva.

Ground color of crown and pronotum ivory, each with a V-shaped discal marking, that of crown yellow, of pronotum, orange; pronotum with a pair of widely-spaced round spots on posterior half of disc, dull yellow, humeral margins pink. Scutellum with ground color dull ivory, basal angles dull orange, a median Y-shaped marking gray, a spot at midlength of each lateral margin, and apex, black. Forewings with ground color gray with a lacteus omega-shaped marking crossing commissure distinctly behind apex of scutellum, its lateral and apical portions as in *vexillifera*, the transverse portion bordered sharply with black anteriorly, with a narrow triundulate red border posteriorly; apical third of clavus pale grayish translucent; a dark gray undulate longitudinal marking on each wing forming an inner border to longi-

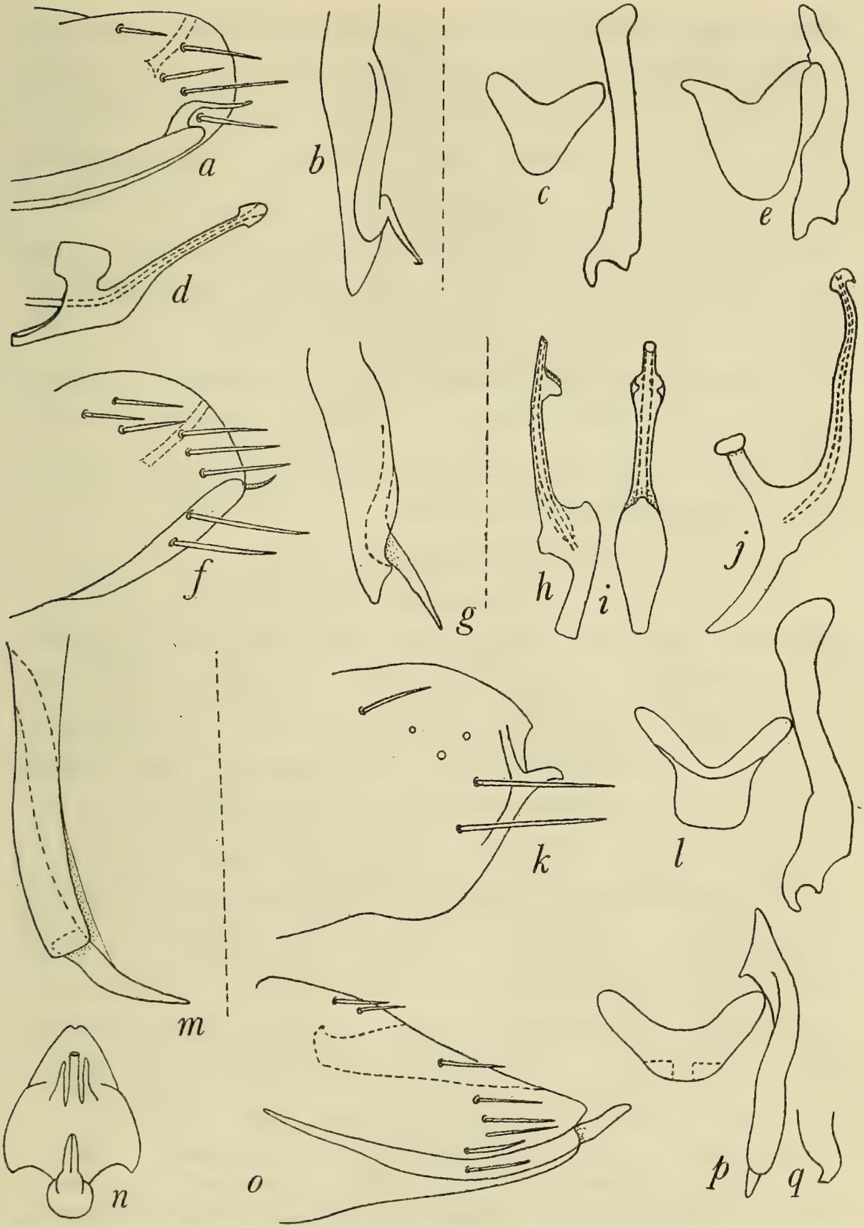

FIGURE 22.—*Omegalebra.* *a–d*, *O. blantoni* (type): *a*, pygofer, lateral aspect; *b*, pygofer process, ventral aspect; *c*, style and connective, dorsal aspect; *d*, aedeagus, lateral aspect. *e–i*, *O. balloui:* *e*, style and connective, dorsal aspect; *f*, pygofer, lateral aspect; *g*, pygofer process, ventral aspect; *h*, aedeagus, lateral aspect; *i*, aedeagus, ventral aspect. *j–l*, *O. morrisoni:* *j*, aedeagus, lateral aspect; *k*, pygofer, lateral aspect; *l*, style and connective, dorsal aspect. *m–q*, *O. ogloblini:* *m*, pygofer process, ventral aspect; *n*, aedeagus, caudal aspect; *o*, pygofer, lateral aspect; *p*, style and connective, dorsal aspect; *q*, style apex, lateral aspect. (In *b*, *g*, and *m* the broken line represents the midline of the specimen.)

tudinal portion of the omega-shaped marking, attaining commissure just behind claval apex, extending thence caudolaterad along bases of apical cells, filling apical portion of third apical cell, thence extending submarginally around wing apex and fading, ending in inner apical cell, a faint fumose marking in first and second apical cells near their midlengths. Face ivory, antennal bases orange; posterior part of pleural portion of pronotum pink; posttibiae as in *vexillifera.*

Holotype male, Loreto, Misiones Province, Argentina, Dec. 6, 1931, (A. A. Ogloblin), in U. S. National Museum (No. 62716); male paratype, Santa Catarina, Nova Teutonia, Brazil, Apr. 29, 1950 (F. Plaumann), in Snow Entomological Collections.

The bizarre form of the aedeagus and the presence of the dorsal apodemes on the anterior margin of the ninth tergum are distinctive features.

The species is named in honor of Mr. Ogloblin, who has collected many interesting species in Argentina.

Omegalebra matogrossana, new species

Figure 23,*a–d*

Length of male 3.2–3.3 mm. Crown with apex broadly rounded; median length equal to interocular width. Pronotum with median length more than one-half greater than median length of crown; posterior margin shallowly concave. Ocelli closer to inner eye margins than to median line of crown. Male plates gradually tapered, exceeding posterior pygofer margin, each with a row of pale macrosetae on middle half. Pygofer with caudoventral margin strongly produced at midlength; disc with few irregularly arranged macrosetae; pygofer process arising ventrally, extending dorsocaudad, exceeding posterior pygofer margin, in lateral aspect slightly expanded on ventral margin near midlength, gradually tapered in apical half; pygofer wall with a diagonal, differentially sclerotized rod extending from anterodorsal portion of disc posteroventrad to pygofer process near its midlength. Ninth tergum with a basal transverse sclerotized rod and a pair of lateral membranous lines, roughly delimiting a tergite which is not delimited apically. Anal processes short, weak. Style elongate, with slight preapical lobe and unmodified apical extension. Connective as in *O. vexillifera* (Baker) but with unpaired portion narrower. Aedeagus with preatrium very short; dorsal apodeme short, T-shaped, shaft short, recurved. Sternal abdominal apodemes not traversing one conjunctiva.

Dorsum as in *vexillifera*, but with posterior portion of omega-shaped marking narrowly double-margined medially, singly margined with black and with veins forming apical cells margined with black. Face, venter and pleural portion of pronotum as in *vexillifera.*

Holotype male and 12 male paratypes, Rio Caraguata, Brazil, March 1953 (F. Plaumann), in Snow Entomological Collections and five male paratypes, same data, in U. S. National Museum. In addi-

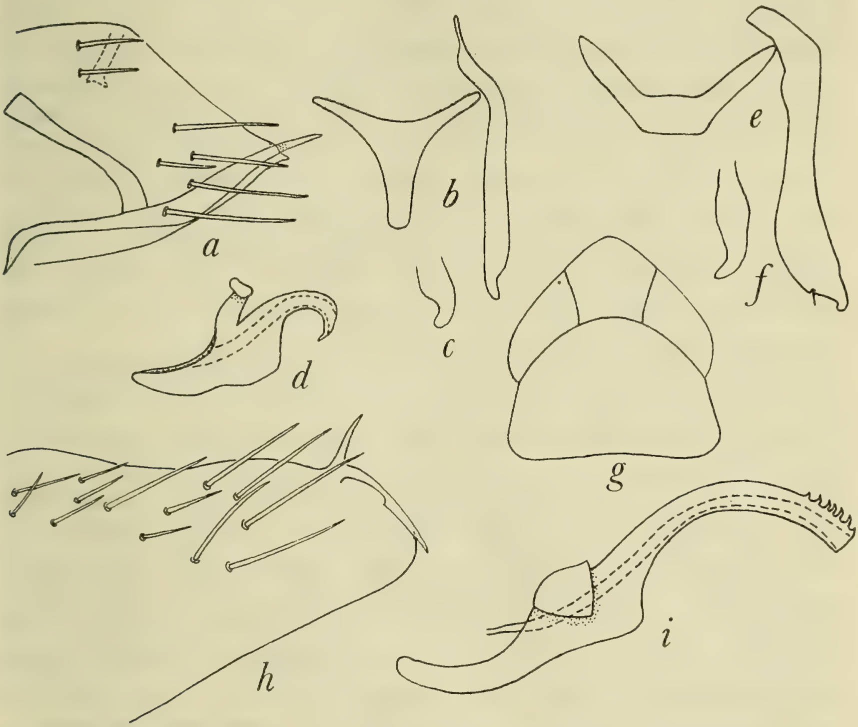

FIGURE 23.—*Omegalebra. a–d, O. matogrossana: a*, pygofer, lateral aspect (broken line represents anal process); *b*, style and connective, dorsal aspect; *c*, style apex, lateral aspect; *d*, aedeagus, lateral aspect. *e–i, O. barbata: e*, style, lateral aspect and connective; *f*, style, ventral aspect; *g*, anterior dorsum; *h*, pygofer, lateral aspect; *i*, aedeagus, lateral aspect.

tion to the type series, a teneral male from São Paulo, Brãzil, was examined from the U. S. National Museum.

Omegalebra barbata, new species

FIGURE 23,*e–i*

Length of male 3.8–3.9 mm., of female 4.0 mm. Crown with apex obtusely rounded; median length slightly greater than interocular width. Pronotum with median length more than one-half greater than median length of crown; posterior margin varying from rectilinear to very shallowly concave. Ocelli as in *O. vexillifera* (Baker). Female seventh sternum with posterior margin greatly attenuate and truncate apically, more than three times length of exposed portion of ovipositor; pygofer

with a few of the macrosetae contrasting black. Male plates each slightly flared apically, exceeding posterior pygofer margin, with row of pale macrosetae from near base to apex. Male pygofer greatly produced posteriorly, posterior margin rounded; dorsal portion of disc with numerous irregularly arranged macrosetae; pygofer process arising on posterodorsal pygofer margin, biramous, the ventral ramus more elongate and directed ventrad. Ninth tergum consisting of a narrow, heavily sclerotized ring dorsally. Anal processes absent. Style with preapical lobe present but not pronounced; apex curved ventrad. Connective broadly V-shaped, not extending caudad to apex of basal half of shank of style. Aedeagus with preatrium elongate; dorsal apodeme a narrow collar dorsally, expanded lateroventrad into an auriculiform process on each side; shaft crescentiform, the dorsal margin with several short, retrorse anteapical teeth. Sternal abdominal apodemes not traversing one conjunctiva.

Ground color of crown, pronotum, and scutellum bright ivory, a pair of dots, and a more posterior pair of dashes on disc of crown, a Y-shaped discal marking and a submarginal row of dots near anterior and lateral margins of pronotum, and basal angles of scutellum yellowish gray; humeral margins of pronotum pink; apex of scutellum black. Forewings with omega-shaped marking as in *vexillifera* but with the transverse portion much more angular, its black anterior and red posterior borders consisting of oblique lines on each wing; humeral portions of wing gray, the triangular area enclosed by the arms of the "omega" tan, and extending caudolaterad along contrastingly paler bases of apical cells, completely filling the triangular third apical cell; outer apical cell and an adjoining submarginal area, lacteus. Face, venter and posttibiae as in *vexillifera*. Apex of female seventh sternum black.

Holotype male, allotype female, and male paratype, Santa Catarina, Nova Teutonia, Brazil, May 4, 1950 (F. Plaumann), in Snow Entomological Collections; paratype male, same data, in U. S. National Museum. A specimen from Campinas, Brazil, in the Pomona College collection has also been examined.

Erabla, new genus

FIGURE 24

Type of the genus, *Protalebra lineola* Osborn.

Hind wing with submarginal vein confluent with apical wing margin; posterior branch of vein R entire, ending in costal margin before apex; vein Cu_2 confluent with submarginal vein at point much basad of vein m-cu. Forewing with appendix not extending around wing apex which is smoothly rounded; inner apical cell much broader in basal third than in remainder of length; second apical cell with length

measured along inner margin more than two-thirds length of inner apical cell measured along the common margin; second and third apical cells triangular and petiolate; outer apical cell not attaining apical wing margin, with length exceeding width. Cells R and M about equal in length and anteapical width. Male plates triangular, in length exceeding posterior pygofer margin, each with a multiseriate group of pale macrosetae in basal half. Pygofer with apical processes and a vertical row of anteapical macrosetae. Ninth tergum heavily

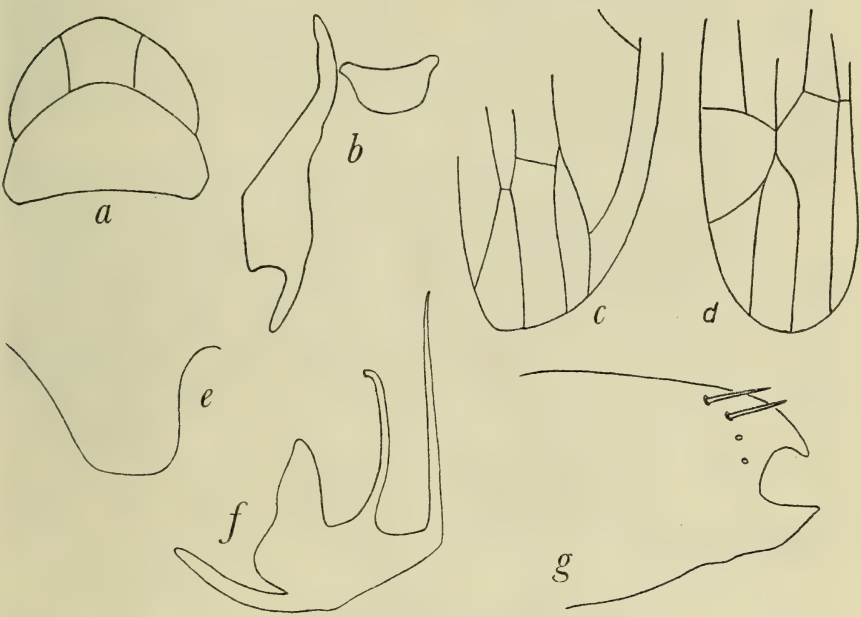

FIGURE 24.—*Erabla lineola* (paratype): *a*, anterior dorsum; *b*, style and connective, dorsal aspect; *c*, apex of hind wing; *d*, apex of forewing; *e*, right sternal abdominal apodeme, ventral aspect; *f*, aedeagus, lateral aspect; *g*, pygofer, lateral aspect.

sclerotized along median line but without a distinct tergite. Anal processes absent. Style with distinct preapical lobe. Connective transverse. Aedeagus with distinct preatrium, dorsal apodeme and ventral unpaired process. Sternal abdominal apodemes short, not traversing one conjunctiva. Head slightly produced and rounded anteriorly with median length of crown about equal to interocular width; ocelli on rounded margin between crown and face, equidistant from eyes and median line of head. Pronotum wider than head including eyes; lateral margins divergent posteriorly. Face slightly convex in lateral aspect, strongly divergent from contour of crown.

Distribution: Guatemala.

Erabla lineola (Osborn), new combination

FIGURE 24

Protalebra lineola Osborn, Ann. Carnegie Mus., vol. 18, p. 263, 1928.

Length of male 2.9 mm. Crown with median length subequal to interocular width. Pronotum with median length almost twice median length of crown. Male pygofer with posterior margin produced and with a deep, curved emargination; with few macrosetae in vertical row on upper half of pygofer. Connective in a transverse vertical plane. Aedeagus with preatrium broad and flat; dorsal apodeme laterally compressed; shaft slender, tubular, elongate, the apex curved slightly cephalad, with an aciculate, unpaired basal process extending caudad near its origin, sharply curved through 90° and extending dorsad beyond apex of shaft.

Crown, pronotum and scutellum dull yellowish brown, the basal angles and median line of scutellum darker. Forewing yellowish translucent before apical cells, with a transverse marking, narrow at midcostal margin, becoming broader towards commissural margin, with three slender oblique vittae extending basad from its anterior margins, one in clavus, two in corium, black; apical cells fumose with hyaline areoles in outer, and base of inner apical cells, and a transverse hyaline anteapical area from third apical cell through appendix. Face and venter dull yellow.

Known only from the type series from Los Amates, Guatemala, in the Ohio State University collection. The above description is based on a male paratype loaned through the kindness of Dr. J. N. Knull of that institution.

Genus *Rabela* Young

FIGURE 25

Rabela Young, Univ. Kansas Sci. Bull. 35, p. 21, 1952 (type *Protalebra tabebuiae* Dozier, by original designation).

Hind wing with submarginal vein obsolete apically; posterior branch of vein R occurring as a short spur; vein Cu_2 confluent with submarginal vein at point much proximad of vein m-cu. Forewing with appendix not extending around apex which is smoothly rounded; veins R and M concurrent before inner basal angle of outer apical cell, all the apical veins thus arising from cell M; inner apical cell narrower basally than at apex; second apical cell parallel-sided; third apical cell long-stalked; outer apical cell longer than broad, not attaining apical wing margin. Female seventh sternum with posterior margin produced posteriorly in a triangular projection which is rounded apically; pygofer with multiseriate pale macrosetae near ovipositor along

posterior two-thirds its length. Male plates elongate triangular, exceeding posterior pygofer margin, each with an oblique double row of pale macrosetae in basal two-thirds. Male pygofer with posterior margin produced posteriorly, with an apical pygofer process, with one or few macrosetae along posterodorsal margin. Ninth tergum heavily sclerotized along middorsal line but without a tergite. Anal processes short and spine-like or absent. Style with preapical lobe well developed or not, apex expanded and truncate in broadest aspect. Connective Y-shaped, with apex slender or very broad. Aedeagus with preatrium distinct; dorsal apodeme bilobed or not; elongate, slender, curved strongly cephalad, without processes. Head with median length of crown exceeding interocular width; ocelli on margin between crown and face, closer to eyes than to median line of head. Pronotum at least one-half longer than crown; broader than head including eyes; lateral margins divergent posteriorly. Face slightly convex, its profile strongly divergent from contour of crown.

Distribution: Florida, West Indies, and South America.

This genus does not appear to be very closely related to the others treated here. The chaetotaxy of the male pygofer and the presence of the preapical lobe of the style are suggestive of a relationship to *Rhabdotalebra* Young, but in *Rabela* the characteristic nearly semicircular form of the aedeagal shaft and the expanded apical portion of the style are quite distinctive.

Key to species of *Rabela*

Forewing with commissure fuscous in basal half of clavus; male with sternal apodemes conspicuous and traversing two conjunctivae; aedeagus with dorsal apodeme bilobed . . . . **tabebuiae,** (Dozier)

Forewing with commissure not dark-margined in basal half of clavus; male with sternal apodemes inconspicuous and traversing one conjunctiva; aedeagus with a single process extending caudad from dorsal portion of apodeme. **australis,** new species

Rabela tabebuiae (Dozier)

FIGURE 25,*a–g*

Protalebra tabebuiae Dozier, Journ. Dep. Agr. Porto Rico, vol. 10, p. 260, 1927·
Protalebra bicincta Osborn, Ann. Carnegie Mus., vol. 18, p. 259, 1928.
Rabela tabebuiae; Young, Univ. Kansas Sci. Bull. 35, p. 22, 1952.

Length of male 2.7–2.8 mm., of female 2.9–3.0 mm. Head very weakly produced, with anterior margin broadly rounded; median length about one-third greater than interocular width. Male pygofer with a submarginal row of four macrosetae near posterodorsal margin, with posteroventral margin produced posteriorly in a short process that is directed dorsocaudad, the two processes parallel in caudal aspect. Anal processes absent. Style with preapical lobe well

developed, with apical extension somewhat expanded and truncate at apex in broadest aspect. Connective with length and least width of the unpaired portion and arms subequal. Aedeagus with cephalic portion of dorsal apodeme giving off a pair of short lobes, each extending ventrolaterad; shaft very long, slender, curved through 180°, its apex directed anteroventrad. Sternal abdominal apodemes conspicuous, fused medially, extending caudad across two abdominal conjunctivae.

Ground color of crown and pronotum ivory, a median longitudinal vitta extending full length of crown and continued over most of pronotum and a pair of broad submarginal vittae, one along each lateral pronotal margin, pale orange. Scutellum unmarked yellow. Forewing translucent, with yellow reflections in portion from base to claval apex, a narrow dark line extending along anal wing margin, continuing apicad along commissural margin to midlength of clavus, thence abruptly laterad to costal margin, broken at claval suture and in corium, a similar transverse black line extending from apex of clavus to costal margin through base of outer apical cell; second and third apical cells heavily black-bordered. Face and venter pale.

The type, a male from Río Piedras, Puerto Rico, is in the U. S. National Museum. Other specimens have been examined from Miami, Fla.; several Puerto Rico localities; St. Thomas, Virgin Islands; and Cayamas, Cuba.

This species occurs on *Tabebuia pallida.*

***Rabela australis*, new species**

FIGURE 25,*h–l*

Length of male 3.0 mm., of female 3.1 mm. Head more angularly produced than in *R. tabebuiae* (Dozier), the apex rounded; median length almost one-third greater than interocular width. Male pygofer with a single macroseta near posterodorsal margin in apical third, with posterior margin strongly produced near midlength, giving off spine-like pygofer process that is directed caudad and slightly mesad, the two processes very slightly convergent in ventral aspect. Anal processes short, spine-like. Style with preapical lobe poorly developed, apex curved laterad, expanded and truncate apically. Connective with unpaired portion much broader than either of the short arms. Aedeagus with dorsal apodeme laterally compressed, with a dorsoventrally flattened apical lobe extending caudad, shaft crescentiform, shorter than in *tabebuiae*, not decurved apically, gonopore on posterior surface in basal third. Sternal abdominal apodemes short, triangular, not fused, extending caudad to point slightly beyond one conjunctiva.

Ground color of crown, pronotum and scutellum dull orange;

crown with disc and a pair of anterior lobes dull ivory; pronotum bordered narrowly with gray posteriorly, with an interrupted arcuate black stripe between gray margin and disc; scutellum with basal angles and a broad median longitudinal marking, smoky, a transverse

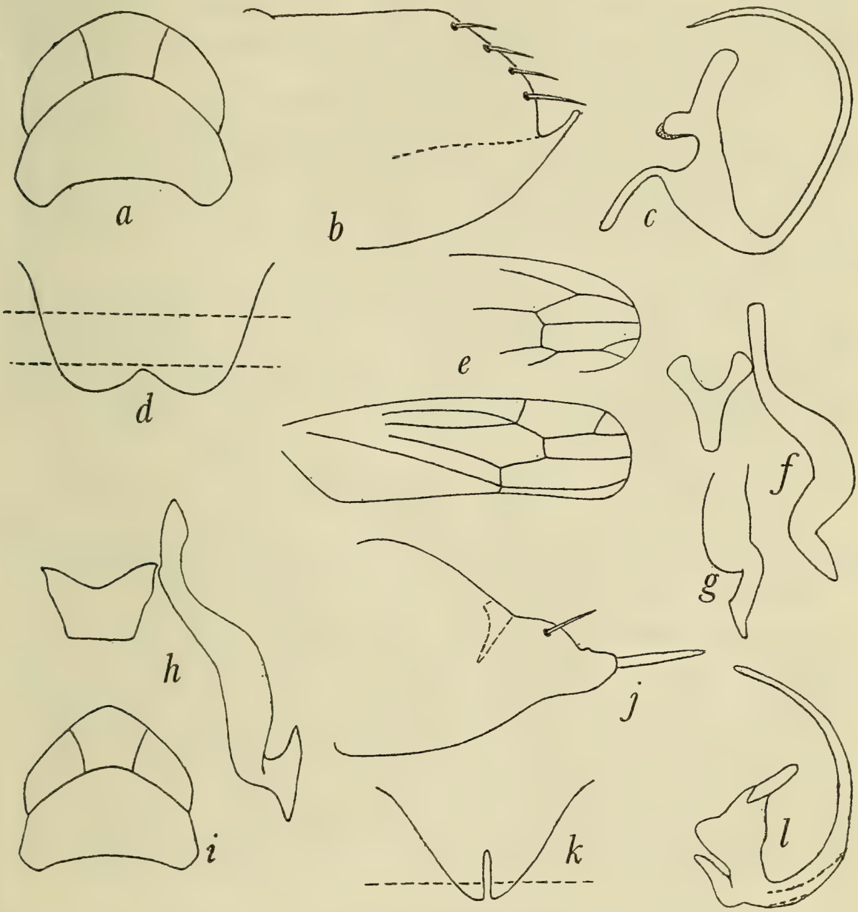

Figure 25.—*Rabela. a–g, R. tabebuiae: a,* anterior dorsum (type); *b,* pygofer, lateral aspect; *c,* aedeagus, lateral aspect; *d,* sternal abdominal apodemes (broken lines represent conjunctivae); *e,* apex of hind wing (above) and entire forewing (below); *f,* style and connective, ventral aspect; *g,* style apex, ventrolateral aspect. *h–l, R. australis: h,* style and connective, dorsal aspect (type); *i,* anterior dorsum (paratype); *j,* pygofer, lateral aspect (broken line represents anal process) (type); *k,* sternal abdominal apodemes (broken line represents conjunctiva); *l,* aedeagus, lateral aspect (type).

anteapical area black, apex ivory. Forewing with ground color greenish brown to claval apex, thence hyaline to wing apex, a bilobate transverse area in basal half of clavus, a spot at claval midlength,

extending laterad through corium and broadening to include costal plaque, gray narrowly margined with black; costal cell with black irrorations anteapically; apex of brachial cell with a yellow areole; second, third and fourth apical veins black; a broad fumose marking covering all of appendix but apex, and all of first and second apical cells but their bases and apices. Face and venter pale; pleural portion of pronotum dull orange to gray; ovipositor black at base and apex, pale in most of apical half.

Holotype male, May 4, 1950; allotype female, May 5, 1950; two male paratypes, May 4, 5, 1950, and three female paratypes, May 5, 1950, from Santa Catarina, Nova Teutonia, Brazil (F. Plaumann), in Snow Entomological Collections, and one male paratype, May 5, 1950, and two female paratypes, May 4, 5, 1950 (other data as in holotype), in U. S. National Museum.

This species can be readily distinguished from *tabebuiae* by its color and the characters mentioned in the key. Its shorter aedeagal shaft which is not decurved apically, the much broader style apices and the absence of paired apodemal processes on the aedeagus will also separate *australis* from the genotype.

Genus *Elabra* Young

FIGURES 26, 27

Elabra Young, Univ. Kansas Sci. Bull. 35, p. 35, 1952 (type *Protolebra eburneola* Osborn, by original designation).

Hind wing with submarginal vein confluent with apical wing margin or nearly so; posterior branch of vein R entire apically; vein Cu_2 confluent with submarginal vein at point much basad of crossvein m-cu. Forewing with appendix not extending around apex which is usually smoothly rounded; inner apical cell narrower at base than at apex (exception: *costaricensis*); second apical cell usually parallel-sided or nearly so, with length less than two-thirds length of inner apical cell; third apical cell as long as or longer than second apical cell

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FIGURE 26.—*Elabra*. *a–c*, *E. eburneola*: *a*, pygofer, lateral aspect (pygofer process and anal process not shown); *b*, style and connective, dorsal aspect; *c*, aedeagus, lateral aspect. *d–h*, *E. parana*: *d*, anterior dorsum; *e*, aedeagus, lateral aspect; *f*, apex of forewing; *g*, style and connective, dorsal aspect; *h*, pygofer, lateral aspect. *i–m*, *E. parallela*: *i*, anterior dorsum; *j*, style and connective, dorsal aspect; *k*, style apex, lateral aspect; *l*, aedeagus, lateral aspect; *m*, pygofer, lateral aspect. *n–q*, *E. morrisoni* (type): *n*, pygofer, lateral aspect; *o*, style and connective, dorsal aspect; *p*, sternal abdominal apodemes (broken lines represent conjunctivae); *q*, aedeagus, lateral aspect. *r–s*, *E. morrisoni isthmusi* (type): *r*, style and connective, dorsal aspect; *s*, aedeagus, lateral aspect. (In *h*, *m*, and *n* the broken lines represent the anal process.)

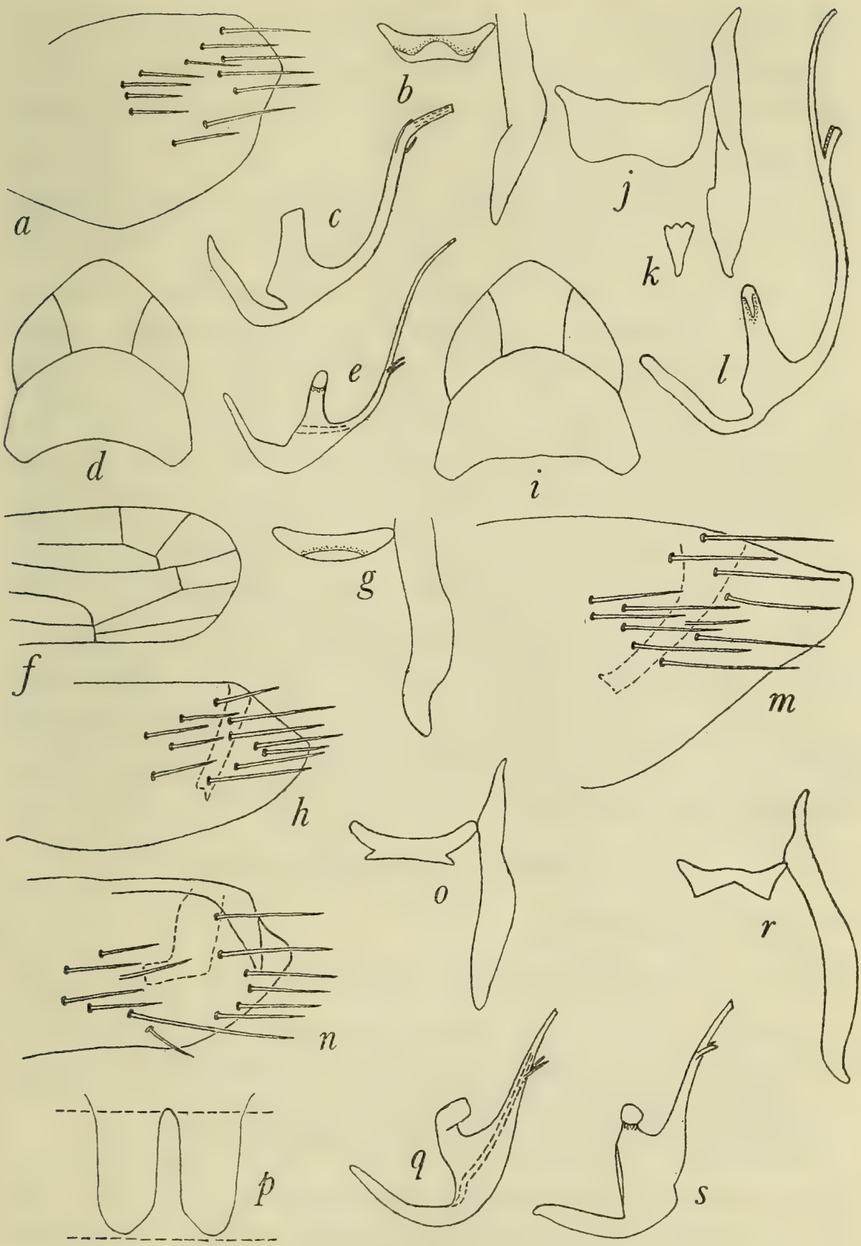

Figure 26.—For explanation see facing page.

(exception: *parallela*); outer apical cell with length equal to or greater than width; cell M wider apically than cell R. Male plates triangular, exceeding posterior pygofer margin, each with an oblique row of macrosetae some of which are conspicuously larger and black (exception: *eburneola*). Pygofer with posterior margin produced or smoothly rounded; with irregularly arranged macrosetae on disc, processes present or absent. Ninth tergite wanting. Anal processes usually present (absent in *sarana*), their length variable interspecifically. Style usually without preapical lobe, with apex slightly decurved. Connective usually in form of crossbar but occasionally shallowly U-shaped or triangular. Aedeagus with preatrium usually present and elongate; dorsal apodeme distinct and bilobed; shaft very slender (exception: *sarana*), with or without processes. Head strongly produced, median length of crown at least one-half greater than interocular width; ocelli on rounded margin between crown and face, equidistant from inner eye margins and median line of head or slightly closer to inner eye margins. Pronotum wider than head including eyes, lateral margins divergent posteriorly. Face strongly divergent from contour of crown in profile. Sternal abdominal apodemes variable interspecifically. Color pale with various markings.

Distribution: Puerto Rico, Central America, and South America.

The relationships of this genus with others are problematical. The elongate, sinuous aedeagus in some species is suggestive of certain species of *Barela*, but the more produced head, the short apical cells of the forewing and the transverse dorsal aedeagal apodeme set the species of *Elabra* well apart.

Key to species and subspecies of *Elabra*

1. Aedeagus with processes 2
   Aedeagus without processes 7
2. Aedeagal process occurring on basal half of shaft; length of male 3.0 mm. (Brazil) . . . . **parana** (Osborn)
   Aedeagal processes arising on apical half of shaft; length of male 3.2–3.6 mm. 3
3. Male pygofer with processes arising on posterior margin and extending ventrad; aedeagus without preatrium (Bolivia). . . . . **sarana** (Osborn)
   Male pygofer without processes; aedeagus with preatrium elongate 4
4. Aedeagal processes arising on apical third of shaft (Bolivia). **eburneola** (Osborn)
   Aedeagal processes arising basad of apical third of shaft 5
5. Aedeagal shaft slender, elongate, bisinuate; length of male 3.6 mm.; forewing with third apical cell triangular (Bolivia, Brazil, Ecuador). **parallela** (Osborn)
   Aedeagal shaft much shorter, straight; length of male 3.2 mm.; forewing with third apical cell sessile . . . . **morrisoni,** new species . . 6

6. Male with anal process strongly foot-shaped apically; dorsal portion of pygofer differentially sclerotized (British Guiana). . . . **morrisoni,** new subspecies
   Male with anal process weakly foot-shaped apically; dorsal portion of pygofer not differentially sclerotized (Panama) . . . . **isthmusi,** new subspecies
7. Aedeagal shaft gradually tapered from base to apex; dorsum marked with fumose only in base of second apical cell of forewing (Puerto Rico). **aureovittata** (DeLong)
   Aedeagal shaft abruptly narrowed in basal half; fumose markings on dorsum more extensive (Costa Rica) . . . . **costaricensis,** new species

Elabra eburneola (Osborn)

FIGURE 26,*a–c*

Protalebra eburneola Osborn, Ann. Carnegie Mus. vol. 18, p. 257, 1928.
Elabra eburneola; Young, Univ. Kansas Sci. Bull. 35, p. 35, 1952.

Length of male 3 mm. Forewing with second apical cell less than half length of first. Male plates without contrasting black macrosetae. Pygofer with posterior margin broadly rounded, disc with fairly numerous irregularly arranged macrosetae on dorsal portion of posterior half; pygofer process short, acute apically in caudal aspect, arising from dorsal portion of caudal margin, directed mesad. Anal processes slender, short, weakly sclerotized. Aedeagus with preatrium elongate; dorsal apodeme semicircular in cephalic aspect; shaft slender and elongate, weakly bisinuate, with a pair of short, obliquely divergent acute processes arising at base of apical fifth; gonopore terminal.

Color: "Ivory-white; elytra tinged with fulvous, a little darker on the apex, with milky-hyaline spots on the cross-nervure and in first and second areoles. Beneath whitish or ivory-white; abdomen a little more tinged with yellow, tarsal claws dusky." (Osborn, loc. cit.)

Known only from the type series from Provincia del Sara, Bolivia, in Carnegie Museum.

Elabra parallela (Osborn)

FIGURE 26,*i–m*

Dikraneura parallela Osborn, Ann. Carnegie Mus., vol. 18, p. 274, 1928.
Elabra parallela; Young, Univ. Kansas Sci. Bull. 35, p. 35, 1952.

Length of male 3.6 mm. Forewing with second apical cell less than half length of first. Male plates with a few of the macrosetae large, contrasting black. Pygofer with posterodorsal margin strongly produced, setae as in *E. eburneola* (Osborn); without pygofer processes or differentially sclerotized integumental areas. Anal processes strong, extending ventrad beyond middle of disc of pygofer. Aedeagus with preatrium elongate; dorsal apodeme transverse with a decurved lobe on each side; shaft as in *eburneola* but with the processes arising

slightly distad of midlength and truncate apically. Sternal abdominal apodemes vestigial.

Ground color of crown, pronotum and scutellum sordid yellow, a median vitta the length of crown, a pair of longitudinal vittae the full length of pronotum traversing disc, outlines of basal angles of scutellum, the lateral margins anteapically and the scutellar apex, orange. Forewing translucent yellow, a longitudinal commissural vitta occupying inner half of clavus in its basal half, entire clavus in apical half except extreme apex, an oblique vitta beginning at base of costa and extending to middle corium at midlength of latter, a vitta bordering inner margin of cell M apically, a spot including base of outer apical cell, and the apical veins, orange; a spot in apex of brachial cell, a spot in base of second apical cell and an oblique costal vitta opposite claval apex, smoky. Face and venter pale yellow; legs pale yellow beneath, suffused with orange above, apical hind tarsomere black.

The type, a male from Provincia del Sara, Bolivia, is in the Carnegie Museum. Males have been examined from Rio Caraguata, Brazil, and Tena, Ecuador. Apparently the apex of the shaft of the aedeagus of the type is missing.

From *eburneola*, to which it is closely related, *parallela* differs in the location of the aedeagal processes which are closer to midlength of shaft, the more produced posterior pygofer margin of the male, the more strongly produced head, and the presence of conspicuous black setae in the row of macrosetae on the male plate. From *parana*, *parallela* differs in its truncate aedeagal processes and their more distal origin on the shaft.

Elabra parana (Osborn)

FIGURE 26,*d–h*

Dikraneura parana Osborn, Ann. Carnegie Mus., vol. 18, p. 268, 1928.
Elabra parana; Young, Univ. Kansas Sci. Bull. 35, p. 35, 1952.

Length of male 3.0, of female 3.3 mm. Forewing with second apical cell less than half length of first. Female seventh sternum with hind margin slightly produced posteriorly at middle, transverse and slightly convex on both sides of the produced portion; pygofer with a conspicuous group of black macrosetae behind midlength. Male plates with some of the macrosetae larger and conspiculously black. Male pygofer with posterior margin produced at midlength, disc with numerous irregularly arranged macrosetae on apical half; no pygofer processes or differentially sclerotized integumental areas. Anal processes extending ventrad beyond middle of disc of pygofer. Aedeagus with preatrium elongate; dorsal apodeme T-shaped, the vertical portion short; shaft as in *E. eburneola* (Osborn) but with

processes arising before midlength, appressed to shaft in ventral aspect. Sternal abdominal apodemes traversing one conjunctiva.

Crown, pronotum and scutellum ivory, a pair of longitudinal vittae over disc of pronotum and extending over basal angles of scutellum, pale yellow. Forewing milky translucent with a faint yellow area along claval commissural margin, and a similarly suffused area in brachial cell. Face and venter pale.

Known only from the holotype and allotype, from Para, Brazil, in the Carnegie Museum collection.

Although closely related to *eburneola* and *parallela*, *E. parana* can be distinguished readily from these by the position of the processes of the aedeagal shaft.

Elabra morrisoni, new species

Figure 26,*n–s*

Length of male 3.2 mm., of female 3.3 mm. Forewing with second apical cell less than half length of first. Female seventh sternum with posterior margin transverse; pygofer with numerous pale macrosetae and a pair of black setae on each side of ovipositor near its midlength. Male plates with several contrasting black macrosetae. Male pygofer with numerous irregularly arranged macrosetae. Anal processes strong, boot-shaped, extending ventrad to middle of disc of pygofer. Aedeagus with preatrium elongate; dorsal apodeme T-shaped, the vertical portion very short; shaft straight, short compared to foregoing species of *Elabra*, with a pair of acute processes near base of apical half.

E. morrisoni can be readily distinguished from the preceding species of *Elabra* by its shorter, straighter aedeagal shaft.

Elabra morrisoni morrisoni, new subspecies

Figure 26,*n–q*

Male pygofer wall with differentially sclerotized bar extending along dorsal pygofer margin and ventrad near posterior pygofer margin, ending opposite lobe of posterior margin; macrosetae occurring generally over disc except near dorsal margin. Anal process foot-shaped with the "toe" large. Sternal abdominal apodemes attaining second conjunctiva.

Dorsum entirely pale yellowish white, the forewings more deeply tinted with yellow. Venter white, the hind tibiae darker at apices and apical hind tarsomere black.

Holotype male and allotype female, Demerara River bank, 2 miles from Georgetown, British Guiana, Sept. 22, 1918 (H. Morrison), in

U. S. National Museum (No. 62683). Specimens have also been examined from Caroni River, Trinidad.

Elabra morrisoni isthmusi, new subspecies

FIGURES 26,*r*,*s*; 27,*a*

Male pygofer with dorsal margin not differentially sclerotized; macrosetae occurring on dorsal portion of posterior half of disc. Anal process similar to that of typical subspecies, but with toe of foot-shaped portion less pronounced.

Ground color of crown, pronotum and scutellum ivory; disc of crown suffused with dull yellow; pronotum with pair of longitudinal yellow vittae, diverging posteriorly and continuous posteriorly with yellow basal angles of scutellum. Forewing yellowish transparent; apical cells fumose, the second apical cell with a darker spot in basal half. Venter and legs as in typical subspecies.

Holotype male, Peña Blanca, Panamá Province, Panama, Oct. 27, 1952 (No. 62684); male paratype, El Retiro, Coclé Province, Panama, Nov. 10, 1952; and a paratype of each sex, Río Hato, Coclé Province, Panama, Jan. 15, 1952; all collected by F. S. Blanton and in U. S. National Museum.

Elabra sarana (Osborn)

FIGURE 27,*b–g*

Dikraneura sarana Osborn, Ann. Carnegie Mus. vol. 18, p. 268, 1928.
Elabra sarana; Young, Univ. Kansas Sci. Bull. 35, p. 35, 1952.

Length of male, 3.2 mm. Forewing with second apical cell more than half length of first. Male plates without contrasting black setae. Pygofer with posterior margin rounded, disc with setae arranged as in *E. eburneola* (Osborn); pygofer process arising along caudal margin, extending anteroventrad. Anal processes absent. Aedeagus with preatrium absent; dorsal apodeme T-shaped, the vertical portion very short; shaft tapered gradually in lateral aspect, constricted near midlength in caudoventral aspect, with a pair of flat, truncate anteapical processes that are divergent from shaft in lateral aspect. Sternal abdominal apodemes absent.

Crown dull orange except sordid white anterior margin. Pronotum and scutellum ivory, with a pair of longitudinal vittae extending over pronotum to hind margin; basal angles of scutellum brown. Forewing milky translucent, a narrow longitudinal claval commissural vitta in basal two-thirds of clavus and an oblique vitta extending from near base of wing through brachial cell longitudinally, and continued through second apical cell almost to apical wing margin, orange. Face and venter pale.

This species is known only from the type, a male, from Provincia del Sara, Bolivia, in the Carnegie Museum.

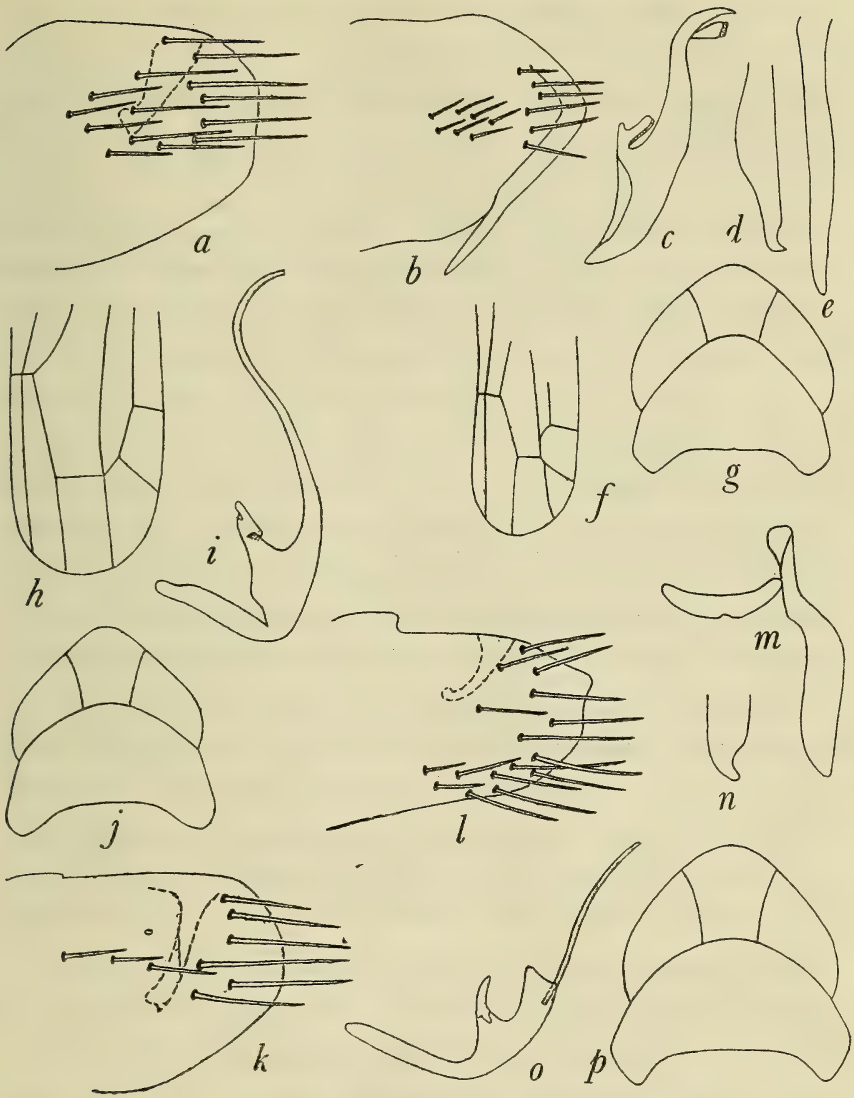

FIGURE 27.—*Elabra.* *a*, *E. morrisoni isthmusi*, pygofer, lateral aspect. *b–g*, *E. sarana* (type): *b*, pygofer, lateral aspect; *c*, aedeagus, lateral aspect; *d*, apical portion of style, lateral aspect; *e*, same, dorsal aspect; *f*, apical portion of forewing; *g*, anterior dorsum. *h–k*, *E. aureovittata: h*, apical portion of forewing; *i*, aedeagus, lateral aspect; *j*, anterior dorsum; *k*, pygofer, lateral aspect. *l–p*, *E. costaricensis: l*, pygofer, lateral aspect; *m*, style and connective, dorsal aspect; *n*, style apex, lateral aspect; *o*, aedeagus, lateral aspect; *p*, anterior dorsum (type). (In *a*, *k*, and *l* the broken lines represent the anal process.)

Elabra aureovittata (DeLong), new combination

FIGURE 27,*h–k*

Alebra aureovittatus DeLong, *in* Wolcott, Journ. Dep. Agr. Porto Rico, vol. 7, p. 267, 1923.
Protalebra pallida Osborn, Ann. Carnegie Mus., vol. 18, p. 260, 1928.

Length of both sexes 3.3 mm. Forewing with second apical cell less than half length of first. Female seventh sternum with posterior margin weakly trilobate, the median lobe more pronounced than lateral ones; pygofer with numerous pale macrosetae and with a pair of black macrosetae each side of ovipositor near its midlength. Male plates with some of the macrosetae contrasting black, conspicuous. Male pygofer with posterior margin rounded, disc with irregularly arranged macrosetae extending from near middle of disc caudad, the group broadening near posterior margin; without pygofer processes or differentially sclerotized integumental areas. Anal processes distinct, extending ventrad beyond middle of disc of pygofer. Aedeagus with preatrium elongate; dorsal apodeme transverse, T-shaped, the vertical portion very short, the extremities each with a vertical lobe; shaft slender, elongate, tapering, bisinuous, without processes. Sternal abdominal apodemes not attaining second conjunctiva.

Dorsum pale yellow to yellowish green, forewing with basal part of commissural margin and brachial cell slightly deeper green; second apical cell with a dusky spot in its base. Face and venter pale, unmarked.

A cotype of *Alebra aureovittatus* DeLong, from the DeLong collection, bearing the label "Acc. 221–1922, Ciales, P. R., Aug. 22, 1922, G. N. Wolcott, collector," and the label "holotype," is here designated lectotype.

Osborn (Journ. Dep. Agr. Porto Rico, vol. 13, p. 105, 1929) and Caldwell (*in* Caldwell and Martorell, 1952, p. 90) are followed in placing the Osborn name in synonymy. The types of *Protalebra pallida* have not been examined. Martorell (loc. cit.) states that the species occurs in association with *Cordia sulcata*. Known only from Puerto Rico.

E. aureovittata differs from the preceding species of *Elabra* in its lack of aedeagal processes.

Elabra costaricensis, new species

FIGURE 27,*l–p*

Length of male 3.8–3.9 mm., of female 3.9–4.0 mm. Forewing with length of second apical cell half or less than half length of first which is of about same width at apex as at base. Female seventh sternum

short, posterior margin transverse; pygofer with numerous pale setae on posterior half and a group of four contrasting black macrosetae near ovipositor slightly distad of its midlength. Male plates with a few of the macrosetae large, contrasting black. Male pygofer with posterodorsal margin produced in a slight lobe, posterior margin truncate or slightly concave, disc with numerous irregularly arranged macrosetae on posterior half; without pygofer processes or differentially sclerotized integumental areas. Anal processes extending to middle of pygofer disc. Aedeagus with preatrium elongate; dorsal apodeme a transverse bar; shaft broad basally, abruptly narrowed at basal third its length, the apical two-thirds slender and weakly sinuate, without processes. Sternal abdominal apodemes traversing one conjunctiva.

Crown yellowish brown except a dull ivory area next anteromesal margin of each eye, the brown color deepening posteriorly and continued and broadening over disc of pronotum, where it is weakly amber-margined laterally, and including the whole scutellum; lateral margins of pronotum broadly ivory. Forewing transparent, suffused with yellow in costa, brachial cell, and before bases of apical cells, a spot at base of commissural margin, a larger, poorly defined one at mid-clavus, a costal area in basal half of costal cell and an oblique vitta in its apical half, base of inner apical cell and of adjacent appendix, and wing apex weakly fumose; a spot in base of second apical cell black. Face and venter pale, apex of hind tibiae and apical hind tarsomere, black.

Holotype male, allotype female, seven male and seven female paratypes, San Pedro de Montes de Oca, Costa Rica, Aug. 14, 1936 (C. H. Ballou), collected from *Vernonia brachiata, Tabebuia pentaphylla,* and "*Cornutia cymosa,*" in U. S. National Museum (No. 62685).

The abruptly narrowed aedeagal shaft of *costaricensis* is unlike all other species of the genus.

Genus *Rhabdotalebra* Young

Figures 28–30

Rhabdotalebra Young, Univ. Kansas Sci. Bull. 35, p. 36, 1952 (type *Protalebra octolineata* Baker, by original designation.

Hind wing with submarginal vein confluent with apical wing margin; posterior branch of vein R evanescent apically; vein Cu_2 confluent with submarginal vein at point much basad of vein m-cu. Forewing with appendix not extending around apex which is smoothly rounded; inner apical cell broader in basal third than in apical half; second apical cell slender, triangular or not, usually narrower at base than at apex; third apical cell stalked, outer apical cell with width exceeding

half length, not attaining apical wing margin, its base distinctly proximad of base of third apical cell. Male plates elongate, triangular, exceeding posterior pygofer margin, with macrosetae confined to basal half. Pygofer with uniseriate, usually oblique group of few submarginal macrosetae along posterodorsal or posterior margin; pygofer process present (exception: *plummeri*), but occasionally not differentially sclerotized, usually directed mesad. Style with preapical lobe present, occasionally weak. Connective transverse, in form of crossbar or shallowly U-shaped. No ninth tergite or anal processes. Aedeagus with preatrium distinct; dorsal apodeme well developed, saddle-shaped in lateral aspect, usually bilobed at base; shaft smoothly curved dorsad, with or without terminal processes; gonopore variously located. Head usually produced, apex rounded; in profile with contour of crown rounded to line of face which is regularly convex; ocelli present, indistinct in some species, on margin between crown and face. Pronotum much longer than crown, wider than head, including eyes; lateral margins divergent posteriorly.

In a recent paper, cited above, the writer stated that ocelli were absent in this genus, an observation since found to be erroneous. In some species the ocelli are difficult to see, but they have now been observed in all the species.

One group of species, consisting of *octolineata*, *signata*, *jamaicensis* and *monrosi*, has a color pattern involving slender longitudinal or oblique black lines on the anterior half of the forewing. Except the last named, all of these lack processes on the aedeagal shaft. *R. monrosi* and the remainder of the species have retrorse shaft processes, and *hambletoni*, *plummeri*, *brunnea* and *ornata* are characterized by a transverse transcommissural color pattern on the forewings.

In addition to the species treated below, *Protalebra lineatella* Osborn (Ann. Carnegie Mus., vol. 18, p. 257, 1928) is placed here provisionally (*new combination*) on the basis of an examination of the female type, from Santa Lucia, Guatemala, in the Ohio State University collection. The color pattern of the type is similar to that of *signata*. Topotypic males are needed to characterize this species.

Key to species and subspecies of *Rhabdotalebra*

1. Chief color markings of anterior two-thirds of forewings consisting of longitudinal or oblique narrow black vittae which are not transcommissural . . . 2
   Chief color markings of anterior two-thirds of forewings transcommissural, not consisting of longitudinal or oblique narrow black vittae 5
2. Forewings each with single black U-shaped marking; pronotum with longitudinal orange vittae; aedeagus with shaft narrowed abruptly in apical half . . 3
   Forewings each with a double black U-shaped marking; pronotum without longitudinal orange vittae; aedeagus with shaft gradually tapered 4

3. Male with pygofer process bifid apically; aedeagal shaft with narrowed portion not more than three times as long as wide . . . . . . **monrosi,** new species
   Male with pygofer process not bifid; aedeagal shaft with narrowed portion more than three times as long as wide . . . . **signata** (McAtee)
4. Male pygofer process bifurcate apically in lateral aspect, not decurved. **jamaicensis,** new species
   Male pygofer process not bifurcate apically, slightly decurved. **octolineata** (Baker)
5. Chief color marking of dorsum an hourglass-shaped white commissural marking; male without pygofer processes . . **plummeri** (Ruppel and DeLong)
   Chief color markings of dorsum otherwise; male pygofer with processes (occasionally not differentially sclerotized) 6
6. Chief color markings of dorsum an inverted "T" extending over pronotum, scutellum and basal half of forewings . . . . . . **hambletoni,** new species
   Chief color markings of dorsum otherwise 7
7. Chief transcommissural markings of dorsum not attaining costal margins of wings; male with apical processes of aedeagus retrorse . . **ornata,** new species
   Posterior marking crossing commissure near midclavus, attaining wing margins at costal plaque of each wing; apical aedeagal process extending laterad, not appressed to shaft . . . . **brunnea** (Oman) . . 8
8. Forewings with ground color tan; anterior transcommissural marking extending without interruption to costal plaque of each wing; sternal abdominal apodemes traversing three conjunctivae . . . subspecies **brunnea** (Oman)
   Forewings with ground color deep red; anterior transcommissural marking ending slightly laterad of claval suture on each wing; sternal abdominal apodemes traversing two conjunctivae . . . . . **colorata,** new subspecies

***Rhabdotalebra octolineata* (Baker)**

FIGURE 28,*a–d*

Protalebra octolineata Baker, Invertebrata Pacifica, vol. 1, p. 7, 1903.
Rhabdotalebra octolineata; Young, Univ. Kansas Sci. Bull. 35, p. 36, 1952.

Length of male 2.7–2.8 mm., of female 2.9–3.0 mm. Crown with apex broadly rounded; median length almost equal to interocular width; posterior margin regularly shallowly concave. Pronotum with median length almost twice median length of crown. Ocelli weak, occasionally observed only with great difficulty, closer to median line of head than to inner margin of eyes. Female seventh sternum short, the posterior margin regularly shallowly concave; pygofer with multiseriate pale macrosetae on posterior two-thirds, the group conspicuously narrowed at its midlength. Male plates gradually tapered from base to apex, greatly exceeding posterior pygofer margin, each with a transverse group of pale macrosetae near base and one or a few macrosetae more distad in basal half. Male pygofer short, subtriangular in lateral aspect, with a submarginal row of few macrosetae near posterodorsal margin; pygofer process arising on posteroventral margin, tapered, acute apically, curved dorsocaudad in lateral aspect, the two processes convergent but not contiguous in ventral aspect. Style with conspicuous pre-

apical lobe and slightly curved apical extension. Connective a transverse bar. Aedeagus with dorsal apodeme bilobed at base; shaft slender, gradually tapering without processes, gonopore terminal on anterior face of shaft. Sternal abdominal apodemes not attaining first conjunctiva.

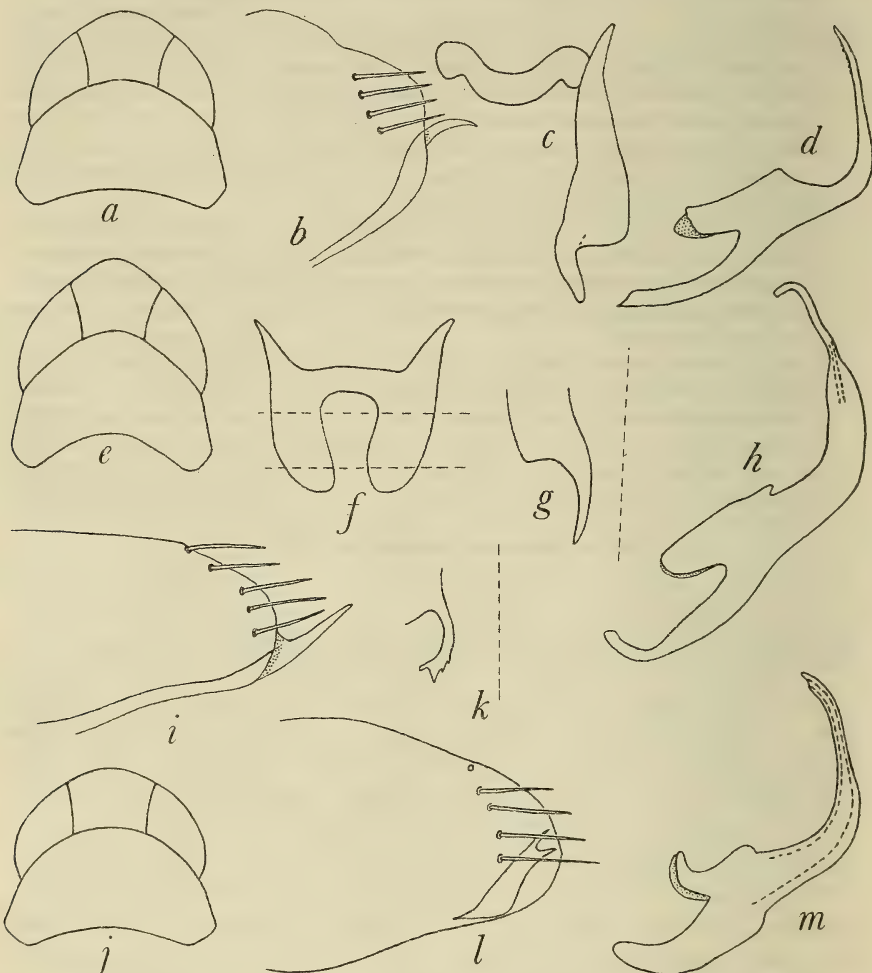

FIGURE 28.—*Rhabdotalebra.* *a–d*, *R. octolineata* (lectotype): *a*, anterior dorsum; *b*, pygofer, lateral aspect; *c*, style and connective, dorsal aspect; *d*, aedeagus, lateral aspect. *e–i*, *R. signata:* *e*, anterior dorsum (type); *f*, sternal abdominal apodemes (broken lines represent conjunctivae); *g*, pygofer process, caudoventral aspect; *h*, aedeagus, lateral aspect; *i*, pygofer, lateral aspect. *j–m*, *R. jamaicensis:* *j*, anterior dorsum (type); *k*, pygofer process, caudal aspect (paratype); *l*, pygofer, lateral aspect (type); *m*, aedeagus, lateral aspect (paratype). (In *g* and *k* the midline of the specimen is represented by a broken line.)

Ground color of crown, pronotum and scutellum dull yellowish green, frequently with a median longitudinal dark stripe on scutellum, occasionally continuous with a similar pronotal stripe that is less commonly present. Forewings greenish hyaline, each with an elongate U-shaped marking of darker green bordered internally and externally with black on basal two-thirds of wing; an obtuse triangular yellow marking traversing commissure at claval apex; inner apical cell of each wing with a black spot touching outer margin in basal third, and a similar spot on vein between third and fourth apical cells. Face and venter pale greenish yellow; posttibial spines uniformly pale; apex of tibiae, apical hind tarsomere, and a median posterior spot on female seventh sternum gray to black.

A male cotype, selected from approximately 95 cotypes in the Pomona College collection, from San Marcos, Nicaragua (collected by Baker), is here designated lectotype. Additional male specimens have been examined from Granada, B. W. I.; Coban, Guatemala (on *Lantana camara*); Middlesex, British Honduras (on *Lantana camara*); New Amsterdam, British Guiana, and Río Tabasara, Chiriquí Province, Panama.

Rhabdotalebra signata (McAtee)

FIGURE 28,*e–i*

Protalebra octolineata var. *signata* McAtee, Journ. New York Ent. Soc., vol. 34, p. 148, 1926.
Rhabdotalebra signata; Young, Univ. Kansas Sci. Bull. 35, p. 36, 1952.

Length of male 2.6–2.7 mm., of female 2.8–3.0 mm. Crown more produced than in *R. octolineata* (Baker), apex broadly rounded; median length more than half greater than interocular width; posterior margin regularly concave. Pronotum with median length less than one-half greater than median length of crown. Ocelli about equidistant from inner eye margins and median line of head. Female seventh sternum with posterior margin slightly convex; pygofer with transverse group of close-set pale macrosetae at midlength, and few more sparsely arranged macrosetae near apex; male plates each with a transverse group of pale macrosetae near base. Pygofer more produced than in *octolineata*, with apical margin smoothly rounded; pygofer setae and process similar to *octolineata* but with apical free portion of latter almost straight in lateral aspect, not or very slightly curved; in caudoventral aspect the two processes subparallel. Other genital characters as in *octolineata* but with aedeagal shaft abruptly narrowed in apical third and with extreme apex curved cephalad, gonopore terminal. Sternal abdominal apodemes traversing two abdominal conjunctivae.

Ground color of crown, pronotum and scutellum pale yellow, a pair of longitudinal vittae extending caudad from near anterior margin of crown, bordering inner margin of each eye, extending caudolaterad across disc of pronotum to its hind border, orange, the vittae occasionally obsolete on crown; a narrow median longitudinal black stripe on pronotum and scutellum; basal and apical angles of scutellum deep yellow. Forewing hyaline tinged with transparent yellow; a thin, narrowly U-shaped mark involving both clavus and corium in basal three-fifths of wing; commissural line narrowly, a diagonal vitta near apex of cell R, a transverse vitta in base of outer apical cell, and a blotch over vein bordering third and fourth apical cells, black, the blotch extended mesad over basal portions of first and second apical cells as a fumose area, an arcuate marking subtending outer portion of wing apex and a pair of transcommissural arcs at level of claval apex enclosing a narrow transverse lenticular hyaline area, fumose. Face and venter yellow, a pink stripe over pleura and pleural portion of pronotum on each side; ovipositor black.

The holotype, from Ancón, Panama Canal Zone, has the abdomen missing. It is in the U. S. National Museum. Additional male specimens have been examined from Costa Rica (on *Tabebuia pentaphylla* (L.)), from Panama Canal Zone, from Darién, Panamá, and Los Santos Provinces, Panama; and from El Valle, Venezuela.

This species is related to *R. monrosi*, new species (q. v.), below.

Rhabdotalebra jamaicensis, new species

FIGURE 28,*j–m*

Length of male 2.7–2.8 mm., of female 2.8–3.0 mm. Crown with apex broadly rounded; median length equal to interocular width; posterior margin regularly shallowly concave. Pronotum with median length more than half greater than median length of crown. Ocelli as in *R. octolineata* (Baker). Female seventh sternum, pygofer and male plates as in *octolineata*. Male pygofer more produced than in *octolineata*, but with similarly arranged macrosetae, posterior margin smoothly convex; pygofer process short, arising on ventral pygofer margin near apex, extending dorsomesad, bifurcate apically, each process with few anteapical teeth on inner margin in caudal aspect. Style, connective and aedeagus as in *octolineata*, but shaft of aedeagus slightly broader in lateral aspect. Sternal abdominal apodemes as in *octolineata*.

Color as in *octolineata*, but slightly more suffused with yellow throughout and with pronotal median dark stripe always present.

Holotype male, allotype female, four female paratypes and two male paratypes, Kingston, Jamaica, Sept. 9, 1917 (Harold Morrison), in U. S. National Museum (No. 62686).

This species is very closely related to *octolineata*, from which it differs conspicuously in its short bifurcate pygofer process.

Rhabdotalebra monrosi, new species

FIGURE 29,*a–e*

Length of male 3.0 mm. Crown with median length about equal to interocular width; posterior margin regularly concave. Pronotum with median length more than one-half longer than median length of crown. Ocelli on broadly rounded margin between crown and face, about equidistant from inner eye margins and median line of head. Male plates as in *R. octolineata* (Baker). Pygofer with posterior margin weakly produced slightly below midlength; pygofer process arising from ventral pygofer margin, directed mesad thence dorsad, distinctly bifid at apex, the two processes subparallel in caudoventral aspect. Style with preapical lobe well-developed. Connective somewhat U-shaped. Aedeagus with shaft laterally compressed, in lateral aspect very broad to short cylindrical apex which is directed dorsocaudad and bears two pairs of short anteapical teeth, gonopore terminal. Sternal abdominal apodemes as in *R. signata* (McAtee).

Crown uniform pale yellow. Pronotum yellowish white with a pair of posteriorly diverging longitudinal orange vittae from anterior to posterior margin. Scutellum pale orange, the apex dark. Forewings as in *signata*, but with transcommissural lenticular area at claval apex wider. Face and venter pale, an orange stripe over pleura and pleural portion of pronotum on each side.

Holotype male, Ledesma, Jujuy, Argentina, Feb. 10, 1950 (Willink and Monrós), in collection of Miguel Lillo Foundation, Tucumán, Argentina.

From *signata*, which it resembles in color pattern and the abruptly narrowed aedeagal shaft, *monrosi* differs in its laterally compressed aedeagal shaft, bifurcate pygofer processes, two pairs of very short processes on the aedeagal shaft, and, in color pattern, in the wider transcommissural lenticular black-margined area at the claval apex.

Rhabdotalebra plummeri (Ruppel and DeLong), new combination

FIGURE 29,*f–j*

Protalebra plummeri Ruppel and DeLong, Ohio Journ. Sci., vol. 53, p. 226, 1953.

Length of male 2.6 mm. Crown well produced, apex rounded; median length more than twice interocular width; posterior margin angularly concave. Pronotum with median length subequal to median length of crown. Ocelli closer to inner eye margins than to median line of head. Female seventh sternum with posterior margin transverse with a very short rounded median lobe; setae as in *R.*

octolineata (Baker). Male plates gradually tapered from base to apex, greatly exceeding posterior pygofer margin, each with a quadrate group of macrosetae in basal half. Male pygofer with posterodorsal

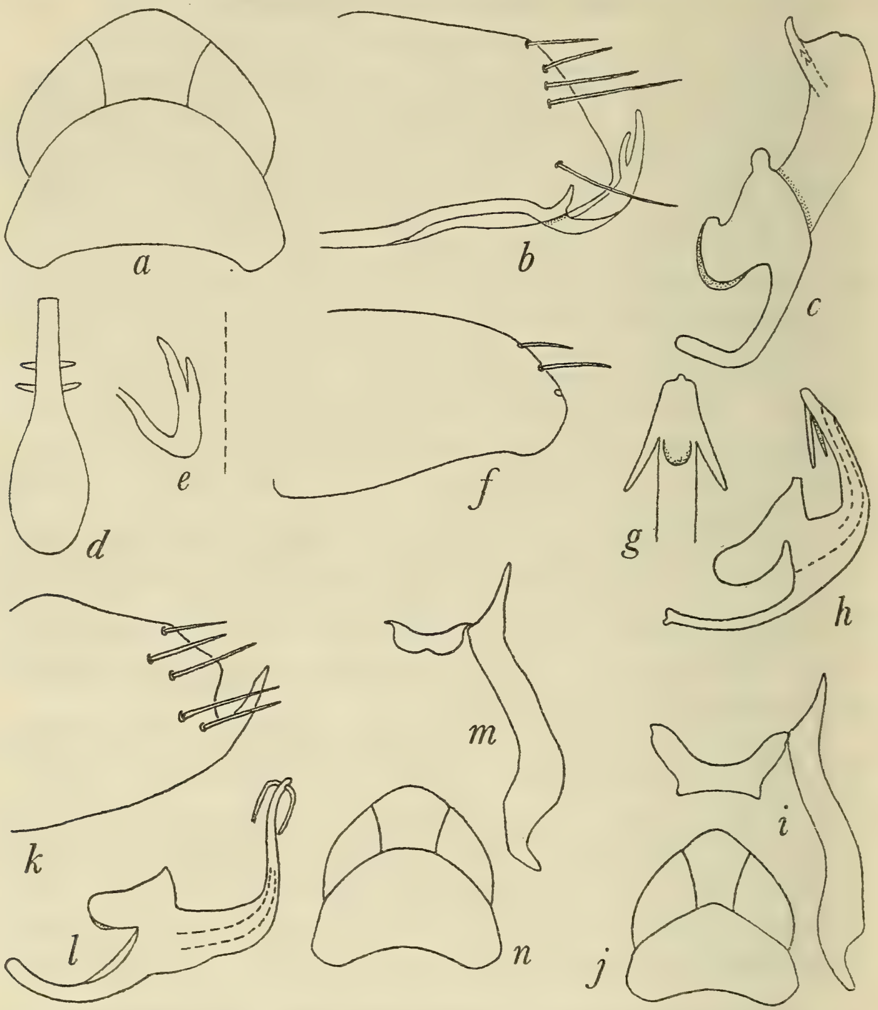

FIGURE 29.—*Rhabdotalebra. a–e, R. monrosi* (type): *a*, anterior dorsum; *b*, pygofer, lateral aspect; *c*, aedeagus, lateral aspect; *d*, aedeagus, caudal aspect; *e*, pygofer process, caudal aspect (broken line represents midline of specimen). *f–j, R. plummeri: f*, pygofer, lateral aspect; *g*, apex of aedeagus, caudal aspect; *h*, aedeagus, lateral aspect; *i*, style and connective, dorsal aspect; *j*, anterior dorsum. *k–n, R. hambletoni* (type): *k*, pygofer, lateral aspect; *l*, aedeagus, lateral aspect; *m*, style and connective, ventral aspect; *n*, anterior dorsum.

margin broadly convex; ventral margin enlarged apically, forming slight ventral pygofer lobe; pygofer processes absent. Style as in *octolineata*. Connective broadly U-shaped. Aedeagus with dorsal

apodeme laterally compressed, not bilobed at base; shaft slender, with pair of anteapical retrorse processes which are not appressed to shaft; gonopore anteapical on caudal surface.

Crown dull yellow with faint paler yellow transverse marking in apical half. Pronotum and scutellum orange, the former with trilobate gray marginal area along posterior margin, with black markings on each side of each lobe; scutellum with anteapical transverse black stripe, apex white. Forewings with basal portions of clavus and corium concolorous with scutellum, the orange area undulate and margined with black posteriorly, the dark margin extending diagonally and undulate posteromesad on each wing to claval suture in basal portion of apical half, recrossing claval suture, thence curved posteromesad to claval apex, outlining a transcommissural, hourglass-shaped, cream-colored area; costal plaque and adjoining corium pale translucent, the translucent area extending into clavus; a confluent marking in anteapical portions of cells R and M, with reversed C-shaped extension into brachial cell, an extension forming a loop in cell R, and an extension to costal margin behind costal plaque, apical veins broadly, except apical portions of first and second apical veins, smoky. Face and venter pale yellow except an orange spot below each eye, confluent with orange propleura, and a longitudinal smoky vitta across meso- and metapleura.

The holotype female, from Mexico, in the DeLong collection, has been examined through the kindness of Dr. DeLong. A single male from Caracas, Venezuela, is in the U. S. National Museum.

Rhabdotalebra hambletoni, new species

FIGURE 29,*k–n*

Length of both sexes 2.9–3.0 mm. Crown with apex broadly rounded; median length one-fourth greater than interocular width; posterior margin regularly concave. Pronotum with median length about one-half greater than median length of crown. Ocelli closer to inner margins of eyes than to median line of head. Female seventh sternum, pygofer and male plates as in *R. octolineata* (Baker). Male pygofer with a submarginal group of macrosetae along posterodorsal pygofer margin; pygofer process arising at apex of posteroventral margin, tapered, acute apically, extending dorsocaudad, the two processes subparallel in ventral aspect. Style broadest before apex but without definite preapical lobe; apical portion short, curved slightly caudoventrad. Aedeagus with dorsal apodeme laterally compressed, weakly bilobed anteroventrally at base; shaft slender, curved dorsad, with pair of slender recurved lateral subapical processes, gonopore terminal on caudal face of shaft.

Crown sordid yellow (holotype) to brown, unmarked. Pronotum and scutellum black, with dark markings of basal half of forewing forming a conspicuous inverted black "T", the transverse portion of which is narrowed towards the costal margins and involves the middle half of the claval commissure; pronotum with lateral margins narrowly pale, and with an indistinct median submarginal pale spot along anterior margin. Ground color of forewings yellowish translucent; apical cells cloudy except hyaline spot in base of inner and outer apical cells and anteapical transverse hyaline area extending from anterior to posterior wing margin and through appendix. Face and venter pale except apex of hind tibiae and of ovipositor which are black.

Holotype male, allotype female, one male paratype and three female paratypes, São Paulo, Brazil (E. J. Hambleton), in U. S. National Museum (No. 62687).

Rhabdotalebra ornata, new species

FIGURE 30,*a–f*

Length of male 2.8–2.9 mm., of female 3.0–3.1 mm. Head with apex sharply rounded, median length almost one-half greater than interocular width; posterior margin regularly shallowly concave. Pronotum with median length one-half greater than median length of crown. Ocelli about midway between inner eye margins and median line of crown in male; closer to eye margins in female. Female seventh sternum short, the hind margin transverse or shallowly concave on each side of a median, slightly produced, strap-like process; pygofer with setae on posterior half, arranged as in *R. octolineata* (Baker). Male plates abruptly narrowed near midlength, slightly exceeding posterior pygofer margin, each with a quadrangular group of macrosetae in basal half. Pygofer with posterodorsal margin oblique, with group of few submarginal macrosetae; apical portion turned mesad, forming short differentially sclerotized process which is rounded dorsally, the two processes approximate but not contiguous in caudal aspect. Style with conspicuous preapical lobe, and strongly curved apical extension. Connective a transverse bar. Aedeagus with dorsal apodeme laterally compressed, weakly bilobed ventrally at base; shaft slender in lateral aspect, curved dorsad, with pair of slender, apical retrorse processes, each of which has a lateral toothlike extension near its base; gonopore subapical on caudal face of shaft. Sternal abdominal apodemes short but traversing one conjunctiva.

Crown pale orange. Pronotum, scutellum and ground color of basal half of forewings bright orange, the basal scutellar angles yellowish. Forewings with a transcommissural, opaque creamy spot in basal halves of clavi and extending laterad into each brachial cell, its anterior

margin rectilinear, its posterior margin convex, and a similarly colored transcommissural spot at claval apices extending laterad on each wing through the brachial cell, bordered anteriorly with deep orange, laterally with pale orange, posteriorly with smoky. Costal plaque translucent pale yellow bordered narrowly with black on mesal and posterior margins. Apex of cell R with a large, translucent yellow spot. Wing apices smoky except an areole in apex of cell R, third and fourth apical cells, and apices of first and second apical cells, all of which are hyaline. Face yellow except a pink spot below each eye on gena; propleural area pink; venter pale to pink except margin of apical process of female seventh sternum and a spot on lower portion of male pygofer on each side, which are black.

Holotype male, allotype female, Apr. 29, 1950, two male paratypes and one female paratype, May 5, 1950, and two female paratypes, May 4, 1950, in Snow Entomological Collections; and one female paratype, May 5, 1950, and one male paratype and one female paratype, May 4, 1950, in U. S. National Museum; all from Santa Catarina, Nova Teutonia, Brazil (F. Plaumann).

Rhabdotalebra brunnea (Oman)

FIGURE 30,*g–q*

Protalebra brunnea Oman, Journ. Agr. Univ. Puerto Rico, vol. 21, p. 567, 1937.
Rhabdotalebra brunnea; Young, Univ. Kansas Sci. Bull. 35, p. 36, 1952.

Length 2.6–2.8 mm. Crown with posterior margin obtusely angulate. Pronotum with median length about one-half greater than median length of crown. Male plates triangular, gradually tapered from base to apex, exceeding posterior pygofer margin, each with a quadrate group of macrosetae in basal half. Pygofer with a submarginal row of macrosetae along posterodorsal margin; posterior margin produced mesad in a process that is truncate dorsally, the two processes approximate in caudal aspect but not contiguous. Connective a transverse bar. Style with poorly defined preapical lobe; apical extension slightly decurved. Aedeagus with gonopore anteapical on caudal surface; a pair of short, strongly divergent, slender, acute processes arising opposite gonopore on anterior surface, extending laterad. Sternal abdominal apodemes well developed. Color pattern including two narrow transclaval, translucent bands.

Rhabdotalebra brunnea brunnea (Oman)

FIGURE 30,*g–m*

For literature citation see synonymy under *R. brunnea*, above.

Length of male 2.6 mm., of female 2.7–2.8 mm. Crown with median length slightly greater than interocular width. Ocelli as in *R. octolineata* (Baker). Female seventh sternum short, the posterior margin slightly produced and rounded at middle. Male with dorsal

aedeagal apodeme bilobed at base. Sternal abdominal apodemes traversing three conjunctivae.

Ground color of dorsum pale tan; posterior margin of pronotum narrowly dull gray; apex of scutellum white; forewings with a transversely oval, translucent lacteus marking crossing commissure anteriorly at scutellar apex, posteriorly slightly beyond claval midlength, the design bordered narrowly with black before and behind, and involving the costal plaques laterally, twice narrowly interrupted with black on each wing at the intersections of the claval suture; an oblique vitta extending from costal margin to inner angle of base of outer apical cell, base and apex of outer apical cell, and anterior margin of transverse, transcommissural oval hyaline areole at claval apex, black; remaining apical veins, a broad area at midlengths of first and second apical cells smoky, their apices hyaline; third apical cell occasionally smoky. Face and legs pale yellow; pleural portion of pronotum dull gray; remainder of venter black; apical portion of ovipositor pale.

The holotype, from Villalba, Puerto Rico, is in the U. S. National Museum. The subspecies is known only from Puerto Rico.

Rhabdotalebra brunnea colorata, new subspecies

FIGURE 30,*n–q*

Length of both sexes 2.7 mm. Crown with median length more than one-third greater than interocular width. Ocelli distinct, about equidistant from inner eye margins and median line of head. Female seventh sternum short, the posterior margin with a short, triangular median projection. Male with dorsal aedeagal apodeme not bilobed at base.

Crown pale gray, the margin between crown and face broadly pale red. Pronotum deep red, the humeral and posterior margins narrowly gray. Scutellum buff, the apex milky. Forewings with ground color opaque red to claval apex, an interrupted circular design in basal halves of two wings lacteus bordered with black, the circular pattern crossing commissure at apex of scutellum and in apical half of clavus, interrupted with red on each wing anteromesad of costal plaque and narrowly with black at two intersections of claval suture with design, and at outer margin of brachial cell; an oblique vitta extending from costal margin to inner angle of base of outer apical cell, the veins bordering outer apical cell, and third apical cell, basal portions of first and second apical cells, and margins of a transverse, transcommissural oval hyaline areole at claval apex, black; a broad area at midlength of first and second apical cells smoky, their apices hyaline. Face yellow; pleural portion of pronotum red; legs pale; male abdom-

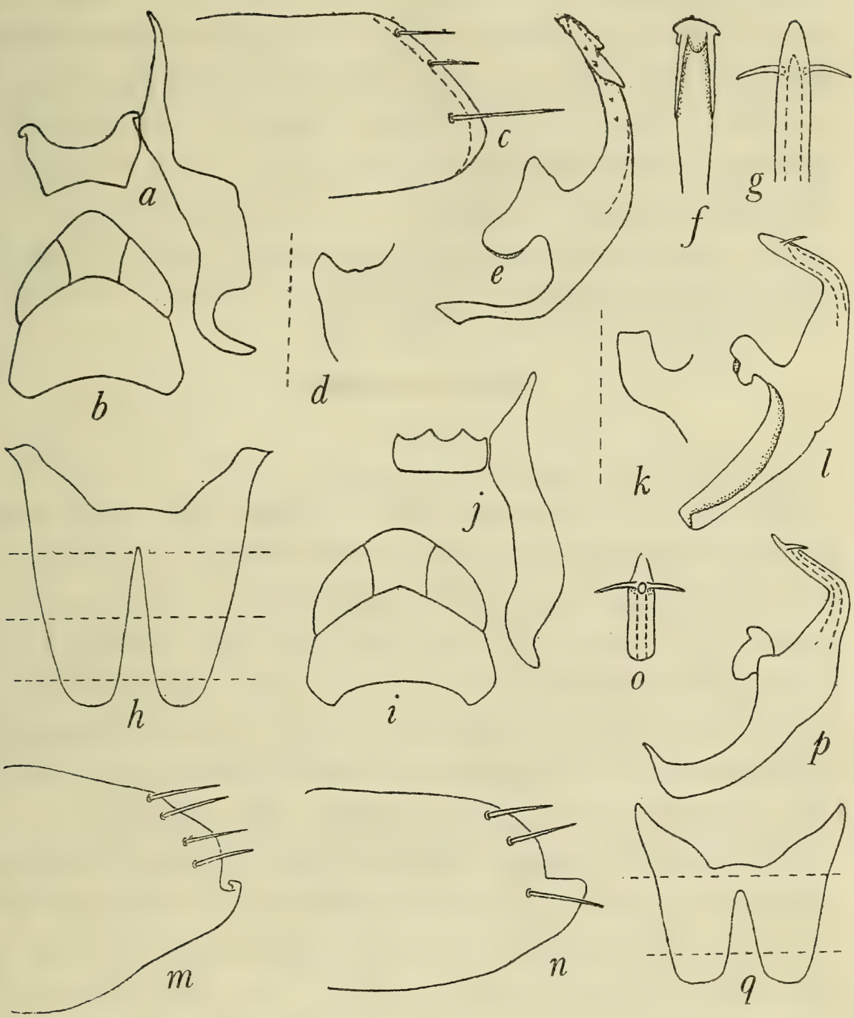

FIGURE 30.—*Rhabdotalebra.* *a–f*, *R. ornata:* *a*, style and connective, dorsal aspect (type); *b*, anterior dorsum (paratype); *c*, pygofer, lateral aspect (type); *d*, same, apex of right side, caudal aspect; *e*, aedeagus, lateral aspect (type); *f*, apex of aedeagus, caudal aspect. *g–m*, *R. brunnea:* *g*, apex of aedeagus, caudal aspect; *h*, sternal abdominal apodemes; *i*, anterior dorsum; *j*, style and connective, dorsal aspect; *k*, pygofer apex, right side, caudal aspect; *l*, aedeagus, lateral aspect; *m*, pygofer, lateral aspect. *n–q*, *R. brunnea colorata:* *n*, pygofer, lateral aspect; *o*, apex of aedeagus, caudal aspect; *p*, aedeagus, lateral aspect; *q*, sternal abdominal apodemes. (In *h* and *q* the broken lines represent conjunctivae.)

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inal venter dark basally, dull yellow apically, except darker ninth sternum and basal portion of plates; female venter dark except for median spot on sixth sternum and the entire seventh sternum except apex, yellow; apical fourth of ovipositor pale yellow or pink.

Holotype male, allotype female, two male and three female paratypes, Santa Catarina, Nova Teutonia, Brazil, Apr. 29, 1950 (F. Plaumann), in Snow Entomological Collections; one male paratype in same collections, and two male and two female paratypes, May 5, 1950 (other data same as holotype), in U. S. National Museum.

This subspecies may be distinguished readily from the typical subspecies by color pattern and the form of the sternal abdominal apodemes, which are longer in *R. b. brunnea.*

Abrela, new genus

FIGURE 31

Type of the genus, *Alebra robusta* Gillette.

Hind wing with submarginal vein confluent with apical wing margin; posterior branch of vein R evanescent apically; vein Cu_2 confluent with submarginal vein at point proximad of vein m-cu. Forewing with appendix not extending around apex which is smoothly rounded; inner apical cell broader near base than in apical half; second apical cell parallel-sided, its width at midlength greater than adjacent width of inner apical cell; third apical cell sessile, subtriangular; outer apical cell longer than broad, not attaining apical wing margin, its base distinctly proximad of base of third apical cell. Male plates exceeding posterior pygofer margin, each with longitudinal group of macrosetae on middle half of length. Pygofer with posterior margin truncate; macrosetae uniseriate, near and parallel to hind margin; pygofer process arising from ventral pygofer margin; pygofer wall with a distinct barlike thickening. Ninth tergum with a distinct triangular sclerite, separated from remainder of tergum by a line of flection. Anal process vestigial. Style elongate, slender, without preapical lobe. Connective a transverse bar. Aedeagus without dorsal apodeme; apex of shaft bifid. Sternal abdominal apodemes traversing one conjunctiva. Head not strongly produced, crown with median length less than interocular width; anterior margin broadly rounded in dorsal aspect; ocelli on broad margin between crown and face, closer to inner eye margins than to median line of head. Pronotum much longer than head; wider than head including eyes; lateral margins strongly divergent posteriorly. Face slightly convex in lateral aspect.

This genus may be closely related to the *Protalebrella* generic complex, which follows. Such a relationship is suggested by the bifurcate

aedeagus which is found in *Beamerulus* and *Diceratalebra*, and by the presence of a distinct ninth tergite which occurs in some stage of development in each genus of the *Protalebrella* complex (there delimited by integumental thickening, instead of line of flection, however). The lack of a dorsal aedeagal apodeme, a prominent structure

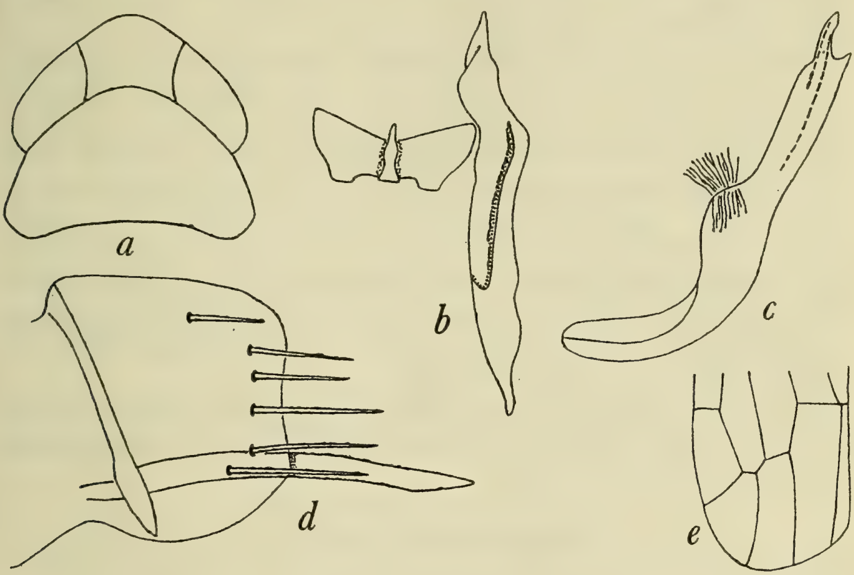

FIGURE 31.—*Abrela robusta: a*, anterior dorsum (type); *b*, style and connective, dorsal aspect; *c*, aedeagus, lateral aspect; *d*, pygofer, lateral aspect; *e*, apex of forewing (in situ).

in the *Protalebrella* complex, the presence of the integumental thickening of the pygofer wall, and the difference in the ninth tergite serve to set *Abrela* apart from the complex.

Abrela robusta (Gillette), new combination

FIGURE 31

Alebra robusta Gillette, Proc. U. S. Nat. Mus., vol. 20, p. 712, 1898.
Diceratalebra robusta; Young, Univ. Kansas Sci. Bull. 35, p. 27, 1952.

Length of female 3.7 mm. Crown with median length slightly less than interocular width. Pronotum with median length twice median length of crown. Female seventh sternum narrow, posterior margin abruptly produced in a conspicuous truncate median tooth; pygofer with macrosetae mostly white, limited to apical half, a few black ones near ovipositor at its midlength. Male pygofer short; anterior portion of disc with pronounced diagonal differentially

sclerotized integumental thickening; pygofer processes elongate, slender, nearly straight, directed caudad and greatly exceeding posterior pygofer margin, the two processes subparallel in ventral aspect. Connective broadly V-shaped with a strong dorsal longitudinal keel. Aedeagus with preatrium elongate, troughlike; shaft bifid apically with the gonoduct in the longer dorsal ramus, dorsal margin in lateral aspect with slight anteapical indentation.

Ground color of crown and pronotum dull yellowish white, an apical and a pair of discal spots on crown and two longitudinal vittae on pronotum extending from near anterior margin to posterior margin, thence slightly laterad along margin, dull orange. Scutellum dull yellow with a broad median gray stripe. Forewings with ground color reddish black except hyaline apical portions of inner three apical cells, an inverted median V-shaped vitta across commissure near midlengths of clavi, four large costal blotches and one in apical half of brachial cell on each wing orange-red; veins in apical half of corium contrasting red; outer apical cell hyaline at base and apex, smoky at middle. Face and venter entirely pale.

Known only from the type, a male from Chapada, Brazil, and a pair of topotypic specimens bearing the same data as the type, all in the U. S. National Museum.

***Beamerulus*, new genus**

Figure 32

Type of the genus, *Beamerulus beameri*, new species.

Hind wing with submarginal vein distinct at apex but forming a part of apical wing margin to apex of vein M_{1+2}; posterior branch of vein R evanescent apically; vein Cu_2 confluent with submarginal vein at point considerably proximad of vein m-cu. Forewing with appendix not extending around apex which is smoothly rounded; inner apical cell slender, not greatly wider in basal third than in apical half; second apical cell parallel-sided; third apical cell triangular or short-petiolate; outer apical cell longer than broad, not attaining apical wing margin, its base distinctly proximad of base of third apical cell; color pattern including a zigzag vitta of red, orange or black. Male plates elongate-triangular, equalling or exceeding posterior pygofer margin, each with single row of setae in apical two-thirds, some of these conspicuously black near middle of row, some fine and elongate apically. Pygofer with posterodorsal margin produced; macrosetae not in rows, arranged roughly parallel to posterior and posteroventral pygofer margin; pygofer process arising on ventral pygofer margin, slender and elongate, crossing midventral line in caudoventral aspect. Ninth tergum with a triangular area before anal tube bounded by distinct

integumental thickening both laterally and apically. Anal processes distinct, elongate, slender, almost attaining ventral pygofer margin. Style elongate, without preapical lobe. Connective triangular or shallowly U-shaped. Aedeagus with preatrium distinct; dorsal apodeme as long as shaft or longer; shaft bifurcate or abruptly narrowed apically. Head strongly produced, crown with median length exceeding interocular width; ocelli on rounded margin between crown and face, about equidistant from inner eye margins and median line of head. Pronotum at least one-half longer than crown, wider than head including eyes; lateral margins strongly divergent posteriorly. Face slightly convex in lateral aspect.

This genus is dedicated to Dr. R. H. Beamer of the University of Kansas, who collected two of the three known species.

Distribution: Mexico.

Beamerulus is closely related to *Diceratalebra*, from which it may be distinguished by its larger size, its color pattern, and its clearly delimited tergal area of the ninth segment. From *Protalebrella*, to which it is also closely related, *Beamerulus* can be distinguished by its distinct anal processes, its larger size and distinctive forewing markings, and its rounded forewing apices.

Key to species of *Beamerulus*

1. Forewing with brown vittae, crown and pronotum unmarked; male pygofer process without a distinct anteapical tooth on mesal margin in caudoventral aspect . . . . **uniceratus**, new species
   Forewing with red vittae, crown and pronotum with orange markings; male pygofer process with a distinct anteapical tooth on mesal margin in caudoventral aspect 2
2. Crown with a pair of submarginal oblique orange markings near anterior margin; aedeagal shaft bifurcate apically . . . . . . **beameri**, new species
   Crown with discal markings only; aedeagal shaft not bifurcate apically. **morelosensis**, new species

***Beamerulus uniceratus*, new species**

FIGURE 32,*a–d*,

Length of male 4.2 mm. Crown with median length one-fifth greater than interocular width. Pronotum with median length one-half greater than median length of crown. Male plates scarcely exceeding posterior pygofer margin. Pygofer with posterodorsal margin strongly produced, subangulate; pygofer process in ventral aspect elongate, slender, gradually curved mesad, crossing midventral line in apical fifth, the mesal margin slightly excavated apically. Aedeagus without a ventral ramus, the ventral margin of shaft, in lateral aspect, narrowing abruptly in apical third of its length; dorsal apodeme elongate, as long as shaft, slightly expanded apically in lateral aspect.

Crown and scutellum ivory, the latter with basal angles dull yellow. Pronotum gray, the humeral areas paler and suffused with brown. Forewing hyaline with a chocolate brown zigzag vitta beginning in base of clavus, extending in clavus along claval suture to midlength, there giving off a short mesal branch to commissural margin, crossing claval suture at midlength and extending posterolaterad to a dark spot at midlength of costa, thence caudomesad, ending in apex of brachial cell; wing apex with an arcuate, deep smoky vitta beginning in basal third of inner apical cell, extending laterad through base of second apical cell, caudad along third apical vein, thence caudad along costal margin into apex of second apical cell. Beneath as in *B. beameri* Young (below) but without markings on pleural portion of pronotum.

Holotype male, Cuernavaca, Morelos, Mexico, Oct. 21, 1941 ("K. 57") (DeLong, Good, Caldwell and Plummer), in collection of D. M. DeLong.

Beamerulus beameri, new species

FIGURE 32,*e–j*

Length of both sexes 4.0 mm. Crown with median length one-fifth greater than interocular width. Pronotum with median length one-half greater than median length of crown. Female seventh sternum with posterior margin broadly convex each side of prominent median tooth which is blunt apically and dark margined; pygofer with three or four black macrosetae on each side of ovipositor near its midlength, in addition to the usual pale macrosetae. Male plates exceeding posterior pygofer margin. Male pygofer with posterodorsal apex rounded; pygofer process appearing crescentiform in caudoventral aspect, chelate apically. Aedeagal shaft bifurcate at apex with ventral ramus greatly reduced, much less than half length of dorsal ramus; dorsal apodeme elongate, exceeding apex of aedeagus. Sternal abdominal apodemes short, not traversing one conjunctiva.

Ground color of dorsum pale cream, crown with two pairs of spots adjoining inner eye margins, the more anterior elongate, submarginal, the more posterior, short, oval, slightly behind middle of disc, pink; pronotum with a transverse vitta across disc before midlength giving off a short straight anterior, and an oblique, longer posterior extension at each end, the anterior extensions not attaining anterior pronotal margin, the posterior extensions attaining and expanded along humeral margins, sanguineous. Scutellum usually with a quadrate, sanguineous median marking at base (absent in holotype). Forewing with a zigzag sanguineous vitta extending from base along claval suture to commissural margin at midclavus, thence posterolaterad

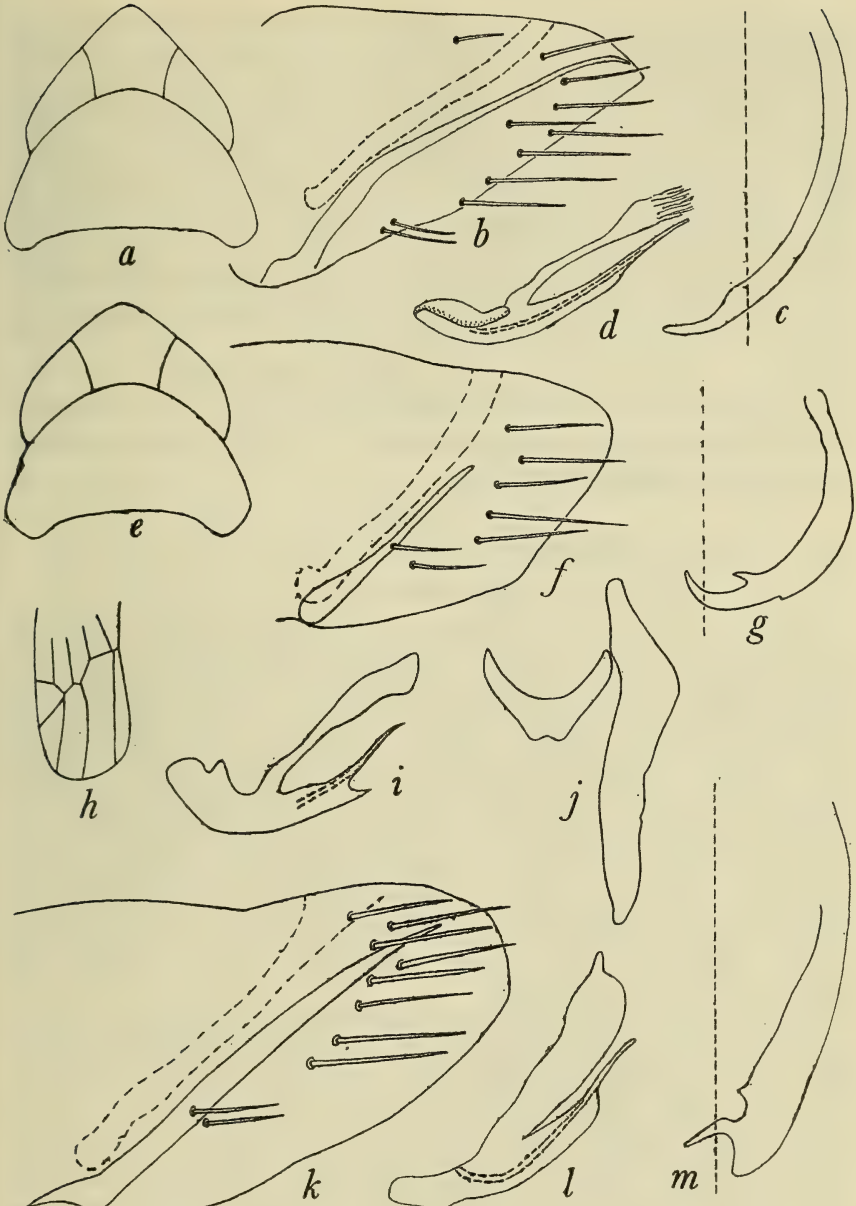

FIGURE 32.—*Beamerulus*. *a–d*, *B. uniceratus* (type): *a*, anterior dorsum; *b*, pygofer, lateral aspect; *c*, pygofer process, caudoventral aspect; *d*, aedeagus, lateral aspect. *e–j*, *B. beameri*: *e*, anterior dorsum (type); *f*, pygofer, lateral aspect; *g*, pygofer process, caudoventral aspect; *h*, apex of forewing; *i*, aedeagus, lateral aspect (type); *j*, style and connective, dorsal aspect. *k–m*, *B. morelosensis* (type): *k*, pygofer, lateral aspect; *l*, aedeagus, lateral aspect; *m*, pygofer process, caudoventral aspect. (In *b*, *f*, and *k* the broken lines represent anal processes; in *c*, *g*, and *m*, the midline of the specimen.)

through corium to a black spot behind midlength of costa, thence arched posteromesad to inner basal angle of inner apical cell and posterolaterad to base of third apical cell; corium with a short arched longitudinal vitta near base of costa, pink to sanguineous; a small spot at claval apex, an arch extending from basal third of inner apical cell posterolaterad through base of second apical cell, along apex of outer apical cell to apical wing margin, along margin through apex of second apical cell, and outer portion of base of outer apical cell, black. Face and venter pale stramineous, apices of hind tibiae black; pleural portion of pronotum with an oblique, sanguineous dash.

Holotype male, allotype female, and two male paratypes, 10 km. north of Cuernavaca, Morelos, Mexico, Dec. 28, 1949 (R. H. Beamer), in Snow Entomological Collections; male and female paratypes, same data, in U. S. National Museum.

Beamerulus morelosensis, new species

FIGURE 32,*k–m*

Length of male 4.5 mm. Crown with median length one-sixth greater than interocular width. Pronotum with median length one-seventh greater than median length of crown. Male plates scarcely exceeding posterior pygofer margin. Pygofer with posterodorsal apex rounded, pygofer processes in caudoventral aspect rounded apically, convergent, each with a pair of mesal anteapical protuberances, the more apical one much longer, slender, slightly curved, crossing the midventral line. Aedeagal shaft with a dorsal apical process, ventral ramus absent; dorsal apodeme exceeding apex of aedeagus, greatly expanded in lateral aspect, its least width exceeding greatest width of shaft. Sternal abdominal apodemes short, not attaining second conjunctiva.

Ground color of dorsum lacteus, head with a narrow line on margin between crown and face, interrupted at apex, and a pair of quadrate discal spots on crown behind middle, touching inner eye margins, pronotum with marking similar to *B. beameri* Young, orange. Scutellum lacteus medially, basal angles very pale yellow, apex black. Forewing with a zigzag vitta as in *beameri*, orange in basal half, sanguineous in apical half, the apical portion twice interrupted basad of apical cells, the base of the vitta, in clavus, extending mesad to point opposite apex of scutellum; corium with basal costal vitta as in *beameri*, orange, dark markings as in *beameri* but outer apical cell almost completely dark margined; clavus with a diffuse pink spot near midlength of apical half; basal fourth of inner apical cell and adjoining appendix pale smoky. Face and venter as in *beameri*.

This species is closely related to and can be easily confused with *beameri*. The styles, the general form of the pygofer processes, the anal processes, the shape of the pygofer and its setal pattern, as well as the color are strongly similar to *beameri*, and force its inclusion in the same genus with *beameri*. From the latter *morelosensis* is distinct in its lack of a ventral aedeagal ramus, its expanded dorsal aedeagal apodeme, the details of the pygofer process and minor details of the color pattern. The aedeagus strongly suggests a relationship to *Protalebrella*.

Holotype male, 10 km. north of Cuernavaca, Morelos, Mexico, Dec. 28, 1949 (R. H. Beamer), in Snow Entomological Collections.

Genus Diceratalebra Young

FIGURES 33, 34

Diceratalebra Young, Univ. Kansas Sci. Bull. 35, p. 26, 1952 (type *Alebra sanguinolinea* Baker, by original designation).

Hind wing with submarginal vein confluent with apical wing margin or not; posterior branch of vein R usually entire apically; vein Cu_2 confluent with submarginal vein at point proximad of vein m-cu. Forewing with appendix usually not extending around wing apex which is rounded; inner apical cell broad basally, narrower in apical half (exception: *pusilla* Young); second apical cell narrow basally, lateral margins almost parallel; third apical cell usually triangular or petiolate; outer apical cell short, not attaining wing apex, its base distinctly proximad of base of third apical cell; color pale marked with orange and black. Female seventh sternum large, posterior margin broadly convex or with a distinct median tooth. Male plates elongate, slender, exceeding posterior pygofer margin, each with single, longitudinal row of macrosetae. Pygofer with posterodorsal portion produced posteriorly, disc with a vertical or oblique group of macrosetae, and occasionally with other additional macrosetae; pygofer process arising on ventral or caudoventral margin or on disc near margin. Ninth tergum with tergite clearly delimited laterally or not, not delimited apically. Anal processes present, usually short, not ending near ventral pygofer margin. Style short, without distinct preapical lobe, slightly curved at apex. Aedeagus short, laterally compressed, appearing bifid at apex, the dorsal ramus containing the gonoduct, dorsal apodeme strongly developed. Head produced with apex rounded. Ocelli on broadly rounded margin between crown and face, about equidistant from inner margins of eyes and median line. Pronotum wider than head including eyes, lateral margins divergent posteriorly. Face in profile with contour usually strongly divergent from line of crown.

Distribution: Southwestern United States, Mexico, Islas Revilla Gigedo, Central America.

The relationship of *Diceratalebra* to *Protalebrella* and *Beamerulus* is discussed in the generic descriptions of those genera. It is also closely related to *Barela*, new genus, no species of which have the bifurcate aedeagal shaft characteristic of *Diceratalebra*.

Key to species of *Diceratalebra*

1. Forewing with appendix extending partially around wing apex; ground color of dorsum olive green, without orange markings; male with pygofer process extending caudodorsad almost parallel to caudoventral pygofer margin (occurs in Texas) . . . . **interrogata** (Knull)
   Forewing with appendix extending to apex but not around it; ground color unmarked pale yellowish or pale yellowish marked with orange; male pygofer process not as above 2
2. Male pygofer process branched apically or with a short anteapical spur . . . 3
   Male pygofer process not so 4
3. Aedeagus with dorsal ramus more than twice length of ventral ramus; male pygofer process with a short anteapical spur; pronotum with short discal parallel orange markings (occurs on Socorro Island) . . . **sola,** new species
   Aedeagus with the two rami of about equal length; male pygofer process bifurcate apically; pronotum with semicircular orange band (occurs in Mexico). **quadricerata,** new species
4. Male pygofer process arising ventrally, extending dorsocaudad 5
   Male pygofer process arising along caudoventral margin, extending caudoventrad . . . . **sanguinolinea** (Baker)
5. Crown of male with median length exceeding interocular width; forewing with third apical cell triangular; dorsum marked with yellow, orange, and black. **caldwelli** (Ruppel and DeLong)
   Crown with median length less than interocular width; forewing with third apical cell quadrilateral; dorsum unmarked pale yellow . **pusilla**, new name

***Diceratalebra sanguinolinea* (Baker)**

FIGURE 33,*a–e*

Alebra sanguinolinea Baker, Invertebrata Pacifica, vol. 1, p. 5, 1903.
Protalebra cubana Osborn, Ann. Ent. Soc. Amer., vol. 19, p. 353, 1926, new synonymy.
Protalebra montana Caldwell, Journ. Agr. Univ. Puerto Rico, vol. 34, p. 96, 1952, new synonymy.
Diceratalebra sanguinolinea; Young, Univ. Kansas Sci. Bull. 35, p. 27, 1952.

Length of male 3.2 mm., of female 3.3 mm. Crown with median length almost one-half greater than interocular width. Pronotum with median length one-third greater than median length of crown; lateral margins slightly divergent posteriorly. Forewing with appendix not extending around apex. Hind wing with submarginal vein confluent with apical wing margin; posterior branch of vein R entire. Face broadly convex in lateral aspect. Female seventh sternum with

posterior margin broadly convex. Male plates triangular, gradually tapered from base to apex, with a row of macrosetae extending from near base to apex. Pygofer with process discal, arising on inner surface, slender, short, curved ventrolaterad. Anal process not attaining middle of disc of pygofer. Connective elongate, triangular with apex rounded, almost attaining style apex, appearing jointed before midlength. Aedeagus short, broad, preatrium wanting, ventral apical ramus shorter and broader than dorsal ramus. Sternal abdominal apodemes traversing one conjunctiva.

Ground color of crown, pronotum, and scutellum dull yellowish white, the pronotum marked with a broad, marginal, orange-red band along anterior and lateral margins. Forewings milky translucent, a vitta in basal half of clavus extending along claval suture, thence abruptly bent mesad to commissure, an irregular oblique vitta extending from near base of coastal margin caudomesad to slightly beyond midlength of brachial cell, a similar oblique vitta extending from coastal plaque to apex of brachial cell, concolorous with pronotal band, apical half of clavus with a faint yellow commissural spot, apical portions of first, second, and third apical cell smoky. Venter entirely dull yellow

Six cotypes from San Marcos, Nicaragua, in the Pomona College collection, have been examined and cotype labels have been affixed. A male cotype from the series is here designated lectotype. Specimens have also been examined from Chinandega, Nicaragua.

The new synonymy above is based on examination of the types of the names involved. The Osborn type and the Caldwell type are in the U. S. National Museum.

Diceratalebra sola, new species

Figure 33,*f–h*

Length of male 2.7 mm., of female 2.8 mm. Crown with median length one-fourth greater than interocular width. Pronotum with median length one-fourth less than median length of crown; with lateral margins not strongly divergent posteriorly. Forewing with appendix not extending around wing apex. Hind wing with submarginal vein confluent with wing apex; posterior branch of vein R entire. Female seventh sternum with posterior margin broadly convex. Male plates each with longitudinal row of small macrosetae on basal half. Pygofer with vertical row of macrosetae extended slightly anteroventrad at lower end; pygofer process arising on caudoventral pygofer margin, short, divergent from posterior pygofer margin in lateral aspect, with a short, ventral spur at midlength; pygofer processes parallel in ventral aspect. Anal process extending

ventrad to middle of pygofer. Connective trapezoidal. Aedeagus similar to that of *D. interrogata* (Knull) (below), but with preatrium and dorsal ramus longer, dorsal apodeme shorter. Sternal abdominal apodemes traversing two conjunctivae.

Ground color of crown, pronotum, scutellum and clavus dull yellow; crown with median longitudinal paler vitta; pronotum with four large orange spots across disc; scutellum unmarked; clavi with a pair of parentheses-shaped vittae (occasionally interrupted) in basal half and each clavus with a spot next apex of scutellum, orange, a faint yellow spot in apical half of clavus. Corium hyaline, a faint yellow, irregular, transverse band opposite claval apex, curved slightly cephalad, terminating laterally in a narrow smoky oblique dash bordering hind margin of costal plaque; apical veins pale bordered with sharply contrasting black; apical portions of first, second and third apical cells smoky. Face and venter pale, bases of posttibial spines apices of posttibiae, and a mesal spot in apical half of each male plate, black.

Holotype male, allotype female, and male paratype, Socorro Island, Revilla Gigedo group, 2,000 ft., May 9, 1925 (H. H. Keifer). Holotype and allotype in collection of California Academy of Sciences, paratype in U. S. National Museum.

This species is closely related to *D. sanguinolinea* but differs in the branched pygofer process not present in the latter. Externally the two species may be readily distinguished by the orange markings of the pronotum forming an inverted "U" in *D. sanguinolinea;* longitudinal vittae in *D. sola.*

Diceratalebra interrogata (Knull)

FIGURE 33,*i–m*

Alebra interrogata Knull, Ent. News, vol. 51, p. 291, 1940.
Diceratelebra interrogata; Young, Univ. Kansas Sci. Bull. 35, p. 27, 1952.

Length of male 2.9 mm., of female 3.1 mm. Crown slightly produced, the apex rounded; median length slightly less than interocular width. Pronotum with lateral margin strongly divergent; posterior margin smoothly, shallowly concave or subangulate. Hind wing with submarginal vein confluent with apical wing margin; posterior branch of vein R entire apically. Forewing with appendix extending partly around apex; venation as in *D. sanguinolinea* (Baker). Female seventh sternum with posterior margin strongly convex. Male pygofer with vertical row of discal macrosetae extended anteroventrad; pygofer process slender and tapered, parallel to posteroventral pygofer margin, the two processes parallel in ventral aspect. Anal

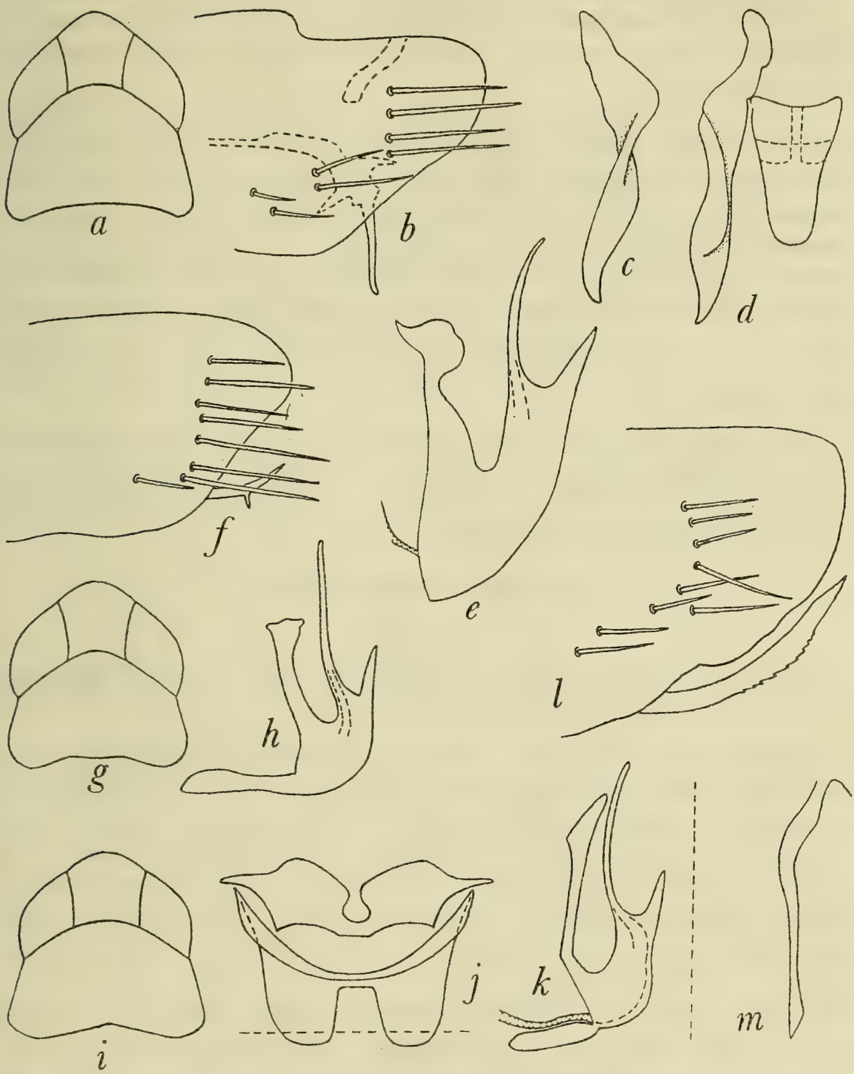

FIGURE 33.—*Diceratalebra.* *a–e*, *D. sanguinolinea:* *a*, anterior dorsum; *b*, pygofer, lateral aspect (dorsal broken line represents anal process); *c*, style, lateral aspect; *d*, style and connective, dorsal aspect; *e*, aedeagus, lateral aspect. *f–h*, *D. sola* (type): *f*, pygofer, lateral aspect, *g*, anterior dorsum; *h*, aedeagus, lateral aspect. *i–m*, *D. interrogata:* *i*, anterior dorsum; *j*, sternal abdominal apodemes and phragma (conjunctiva represented by broken line); *k*, aedeagus, lateral aspect; *l*, pygofer, lateral aspect; *m*, pygofer process, caudoventral aspect (broken line represents midline of specimen).

process not attaining middle of disc of pygofer. Connective weak, subtrapezoidal. Aedeagus as in *D. sanguinolinea* but with dorsal apodeme more elongate and with dorsal ramus much longer in comparison to ventral ramus. Sternal abdominal apodeme traversing one conjunctiva.

Ground color of crown, pronotum, scutellum, clavus and basal half of corium dull yellowish green, a dull white median vitta extending full length of crown, and continued over pronotum as dull gray vitta, extending laterad along posterior pronotal margin; lateral margins of pronotum broadly dull gray. Forewing with conspicuous hyaline spots at midlength of clavus, near base of corium, and in brachial cell and cell M near midlength of wing; costal plaque hyaline; apical third of wing hyaline, the apical veins contrasting ivory bordered with black; apical portion of each of inner three apical cells smoky. Face and venter pale.

The type, a male from Starr County, Tex., is in the collection of Dr. D. J. Knull. The above description is based on topotypic paratypes in the U. S. National Museum. The species is known from Texas and northeastern Mexico.

Diceratalebra pusilla, new name

Figure 34,*a–f*

Protalebra pallida Ruppel and DeLong, Ohio Journ. Sci., vol. 53, p. 228, 1953 (nec Osborn, 1928, p. 260), new synonymy.

Length of male 3.3 mm. Crown with median length about one-sixth less than interocular width. Pronotum with median length almost twice median length of crown. Forewing with appendix not extending around apical wing margin; inner apical cell broadest at midlength, not distinctly broader at base than at apex; second apical cell about half length of inner apical cell; third apical cell quadrangular. Hind wing with submarginal vein confluent with apical wing margin; posterior branch of vein R entire apically. Male plates triangular, scarcely exceeding posterior pygofer margin in ventral aspect, each with a row of macrosetae extending over middle half. Pygofer process arising from ventral pygofer margin near base, in lateral aspect extending posterodorsad and curved caudad in apical third, in caudoventral aspect the two processes contiguous at their acute apices. Anal process not attaining middle of disc of pygofer. Connective a transverse bar. Aedeagus shorter than dorsal aedeagal apodeme; preatrium distinct; ventral ramus of aedeagal apex less than one-fourth length of dorsal ramus.

Ground color of dorsum pale yellow, the forewing translucent, with an areole at apex of cell R and of cell M, and areoles of all apical cells,

hyaline; a spot at base of second apical cell, an oblique dash before midlength of first apical cell, and vein at base of outer apical cell, fumose. Face and venter entirely pale yellow.

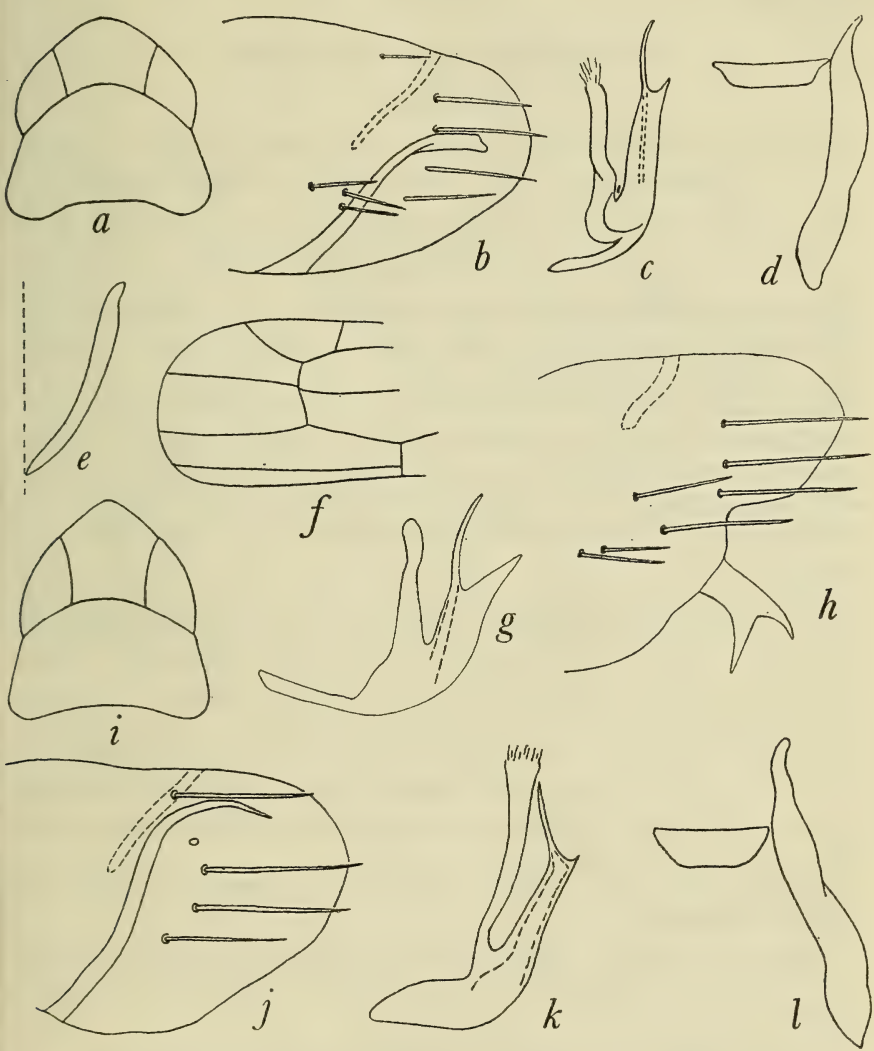

FIGURE 34.—*Diceratalebra.* *a–f*, *D. pusilla* (type); *a*, anterior dorsum; *b*, pygofer, lateral aspect; *c*, aedeagus, lateral aspect; *d*, style and connective, ventral aspect; *e*, pygofer process, caudoventral aspect; *f*, apex of forewing (in situ). *g–h*, *D. quadricerata:* *g*, aedeagus, lateral aspect; *h*, pygofer, lateral aspect. *i–l*, *D. caldwelli* (type): *i*, anterior dorsum; *j*, pygofer, lateral aspect; *k*, aedeagus, lateral aspect; *l*, style and connective, dorsal aspect. (In *b*, *h*, and *j* the broken lines represent anal processes; in *e*, the midline of the specimen.)

This species is known only from the type, a male from Iguala, Guerrero, Mexico, in the DeLong collection. The above description is based on the type, which was examined through the kindness of Dr. DeLong.

Diceratalebra quadricerata, new species

FIGURE 34,*g,h*

Length of male 3.0 mm. Crown with median length one-third greater than interocular width. Pronotum with median length less than one-half greater than median length of crown. Forewing as in *D. sanguinolinea* (Baker). Hind wing with submarginal vein confluent with wing apex; posterior branch of vein R entire. Male plates exceeding posterior pygofer margin; row of macrosetae extending from near base almost to apex. Pygofer with irregular, oblique group of macrosetae parallel to caudoventral margin; process arising on posteroventral margin, short, stout, bifurcate apically, directed caudoventrad. Anal process weak, not attaining middle of disc of pygofer. Connective in form of cross-bar. Aedeagus with preatrium well developed, shaft bifid apically, the dorsal ramus more slender and longer than ventral ramus. Sternal abdominal apodemes traversing two conjunctivae.

Crown ivory. Pronotum, scutellum and forewings translucent white, an arcuate marking on pronotum extending along anterior margin from one humeral margin to other, each forewing with a constricted vitta in basal half of clavus, an oblique angulate vitta from basal fourth of costa to claval suture at midlength, and an oblique vitta from midcosta to claval apex, orange, the last vitta darkened at costal margin; a pale yellow commissural spot in apical half of clavus; apical veins bordered with and first and second apical cells filled with fuscous. Face and venter pale.

Holotype male, "M. B. 260," Mexico (A. Dampf), in collection of D. M. DeLong.

The arcuate orange pronotal band readily separates this species from *D. sola*, the only other species in the genus with a forked pygofer process.

Diceratalebra caldwelli (Ruppel and DeLong), new combination

FIGURE 34,*i–l*

Protalebra caldwelli Ruppel and DeLong, Ohio Journ. Sci., vol. 53, p. 228, 1953.

Length of male 3.2 mm. Head strongly produced; crown with median length almost one-third greater than interocular width. Pronotum with median length about one-sixth greater than median

length of crown. Forewing with appendix not extending around wing apex; third apical cell triangular. Hind wing with submarginal vein confluent with wing apex; posterior branch of vein R evanescent apically. Face broadly convex in lateral aspect, weakly divergent from profile of crown. Male plates triangular, gradually tapered from base to apex, each with longitudinal row of conspicuous black spatulate macrosetae on middle half of length. Pygofer with process arising on ventral margin near base, elongate, tapering, acute apically, curving dorsomesad, thence caudad. Anal process attaining middle of disc of pygofer. Connective a transverse bar. Aedeagal shaft shorter than dorsal aedeagal apodeme, preatrium distinct, ventral apical ramus consisting of a very short tooth.

Dorsum dull, pale yellowish, the forewings translucent, a spot in basal half of clavus and one before apex, two faint spots in basal half of corium and a portion of costal margin before outer apical cell, faint yellow; claval apex and a curved marking extending through base of third apical cell, an area at apex of outer apical cell, thence narrowing along costal margin to near apex, black; bases of first and second apical cells narrowly smoky; apices of cells R and M orange. Face and venter pale, apical hind tarsomeres and the spatulate macrosetae of the male plates contrasting black.

This species is known only from the type series, from Mexico. The holotype has been examined through the kindness of Dr. DeLong.

Genus *Protalebrella* Young

Figures 35, 36

Protalebrella Young, Univ. Kansas Sci. Bull. 35, p. 38, 1952 (type *Protalebra brasiliensis* Baker, by original designation).

Hind wing with submarginal vein not distinct from apical margin; posterior branch of vein R entire apically, vein Cu_2 confluent with submarginal vein near midlength of wing. Forewing with apex obliquely truncate or falcate, appendix not extending around apical wing margin; second apical cell parallel-sided; third apical cell triangular or petiolate; outer apical cell broad, short, not attaining wing apex, its base distinctly proximad of base of third apical cell. Male plates elongate-triangular, exceeding pygofer, each with longitudinal group of macrosetae throughout length. Pygofer with few macrosetae; pygofer process arising dorsally or along posterior pygofer margin. Ninth tergite and anal processes absent. Style usually short, with or without preapical lobe. Connective usually a transverse bar. Aedeagus entirely without processes, with dorsal apodeme slender and elongate, preatrium usually well developed. Head transverse or triangular, the apex rounded or acute in dorsal aspect;

in lateral aspect with face convex and strongly divergent from contour of crown; ocelli on rounded margin between crown and face, equidistant from inner eye margin and median line of head, or slightly nearer the latter. Pronotum with lateral margins divergent posteriorly, posterior margin broadly, shallowly concave.

Distribution: Neotropical Region.

Protalebrella is closely related to *Beamerulus*, in the above discussion of which distinguishing characters are mentioned. It is also closely related to *Barela* and *Diceratalebra*, neither of which contains species with the forewing apices truncate or falcate, with anal processes completely absent, or with pygofer processes arising dorsally or caudally on the pygofer, all of these features being characteristic of *Protalebrella*. From *Diceratalebra*, *Protalebrella* is further differentiated by its lack of a distinct ventral process at the apex of the aedeagal shaft, although the abrupt narrowing of the shaft suggests that such a process has been lost phyletically. None of the species of *Protalebrella* are marked with orange or green diagonal vittae, of common occurrence in *Barela* and *Diceratalebra*. The orange-marked species of *Protalebrella* have transverse markings.

As this paper goes to press, a new species of *Protalebrella*, *P. schachovskoyi* Torres (Neotropica, vol. 1, p. 89, 1955) comes to hand. Torres' species is very closely related to *P. iris*, new species, below, but the latter appears distinct in its single row of macrosetae on the male plate and its shorter sternal abdominal apodemes.

Key to species of *Protalebrella*

1. Forewing with anal margin bordered with black 2
   Forewing not so 3
2. Length 3 mm. or less; crown with median length equal to or slightly less than interocular width; male pygofer process not bifurcate at apex. **brasiliensis** (Baker)
   Length 3.3 mm.; crown with median length almost one-half greater than interocular width; male pygofer process bifurcate apically. **conica** (Ruppel and DeLong)
3. Chief color marking of dorsum an inverted sagittate transcommissural figure; forewing with second apical cell less than half length of first; male pygofer process arising dorsally, extending caudoventrad . . . . . **iris**, new species
   Chief color marking of dorsum consisting of undulate transverse vittae; forewing with length of second apical cell half or more length of first; male pygofer process not extending caudoventrad 4
4. Male with pygofer processes elongate, extending caudad much beyond posterior pygofer margin; aedeagus not abruptly narrowed at midlength. **terminata** (Baker)
   Male pygofer processes not as above, aedeagus abruptly narrowed near midlength. 5
5. Male pygofer with an elongate process extending ventrad in addition to short bifurcate process . . . . **parana**, new species
   Male pygofer with short bifurcate process only. . . **panamensis**, new species

Protalebrella brasiliensis (Baker)

FIGURE 35,*a–f*

Protalebra brasiliensis Baker, Psyche, vol. 8, p. 405, 1899.
Protalebrella brasiliensis; Young, Univ. Kansas Sci. Bull. 35, p. 39, 1952.

Length of male 2.7–3.0 mm., of female 2.9–3.0 mm. Head only slightly produced, median length of crown equal to or slightly less than interocular width. Pronotum with median length one-half greater than median length of crown; width exceeding width of head including eyes. Ocelli about midway between inner margin of eye and median line of head. Female seventh sternum large, posterior margin transverse, broadly convex, with a very minute median tooth. Male plates each with a single submarginal row of macrosetae. Male pygofer short, in lateral aspect with posterodorsal margin produced posteriorly in a rounded lobe that gives rise to an elongate, slender pygofer process directed ventrad and slightly mesad, the apex acute and exceeding posteroventral pygofer margin. Style short, preapical lobe present, apical extension curved slightly posteroventrad. Connective in form of transverse bar. Aedeagus with preatrium short; shaft tapering in basal half, slender and very slightly arched caudad in apical half. Sternal abdominal apodemes not traversing one conjunctiva.

Crown straw yellow to sordid yellow with a median short dark marking near posterior margin; disc with a pair of ocellus-like darker markings near anterior margin. Pronotum, except yellow lateral margins, black, with three submarginal spots behind disc of crown yellow, with four longitudinal narrow streaks extending from near midlength to hind margin dull yellow to bluish gray. Scutellum concolorous with pronotum, the median line and a dot on each side along transverse sulcus, yellow. Forewing with ground color golden yellow, a streak along anal margin and basal half of commissure ending beyond midlength of clavus in a dark-bordered translucent areole, black, a broad black vitta extending from costal plaque caudomesad to touch claval suture opposite end of claval vitta, thence narrowly caudad in brachial cell almost to its apex thence laterad to include entire anteapical portion of the wing including the apices of the anteapical cells, enclosing translucent areoles near clavus, in apex of cell R and of cell M, in base of first and of second apical cells, and in outer apical cell; wing apex narrowly translucent. Venter entirely pale except a dark spot along mesal margin near midlength of each male plate. Abdominal dorsum with a black marking near base and another near apex.

Some variation has been noted in the length of the pygofer processes of the male (fig. 35,*b*,*d*), but supporting evidence is lacking for considering the males with atypically shorter processes as distinct taxa, and males with such processes have been found in samples from populations typical in the character.

The type, a male from Chapada, Brazil, is in the U. S. National Museum. Male specimens have been examined from the following localities: UNITED STATES: *Georgia:* Savannah. *Florida:* Orlando, Sanford, Biscayne Bay, LaBelle, Key Largo. CUBA: Caimito, Habana, Santiago de las Vegas, Baracoa, Santo Tomás, Taco Taco, Balúa Honda. HAITI: Port au Prince. DOMINICAN REPUBLIC: Santo Domingo, San Cristóbal. PUERTO RICO: Mayagüez, Adjuntas, Bayamon, Aquadilla, Utuado, Arecibo, Río Piedras, Carite Mountain, El Pastilli, Aibonito, Cambalache, Loiza, Vieques Island. VIRGIN ISLANDS: St. Thomas. BRITISH WEST INDIES: Trinidad. JAMAICA: Kingston, "I. Baron Trelawney." BRITISH HONDURAS: Punta Gorda. VENEZUELA: Caracas, El Valle. ECUADOR: Tena. BRAZIL: Campinas, Rezende, Nova Teutonia, Belem, Escada, Niteroi, Chapada, Rio Caraguata. PARAGUAY: Villarica. ARGENTINA: Tucumán, Chaco Province, Santa Fé Province. PANAMA: Coclé, Darién, Herrera, Los Santos, and Panamá Provinces. BOLIVIA: Provincia del Sara.

This species has been taken from grasses and bushes.

Protalebrella conica (Ruppel and DeLong), new combination

FIGURE 35,*g–j*

Protalebra conica Ruppel and DeLong, Ohio Journ. Sci., vol. 53, p. 228, 1953.

Length of both sexes 3.3 mm. Crown narrowly triangular with apex rounded, median length about one-half greater than interocular width. Pronotum short, broad, median length less than one-half greater than median length of crown; lateral margins strongly divergent posteriorly. Ocelli closer to median line than to inner eye margins. Female seventh sternum large, hind margin strongly produced medially, the apex acute or sharply rounded. Male plates gradually tapered from base to apex, each with a single row of macrosetae. Male pygofer with posterior margin concave, posteroventral angle extending mesad as a short process, acute and recurved apically; pygofer process arising dorsally near posterior pygofer margin, extending ventrad, widely bifurcate at apex. Style without distinct preapical lobe, bisinuate in lateral aspect, the apex acute and curved caudoventrad. Connective Y-shaped, the unpaired portion short and thick. Aedeagus with preatrium well developed; dorsal apodeme much broader, the shaft shorter and broader than in *P. brasiliensis* (Baker).

Color greatly variable in intensity. The following description refers to well-marked specimens. Ground color of crown, pronotum and forewings pale yellow. Pronotum with a broad median longitudinal black vitta extending from margin to margin, the median line contrastingly paler throughout. Scutellum black, the median line

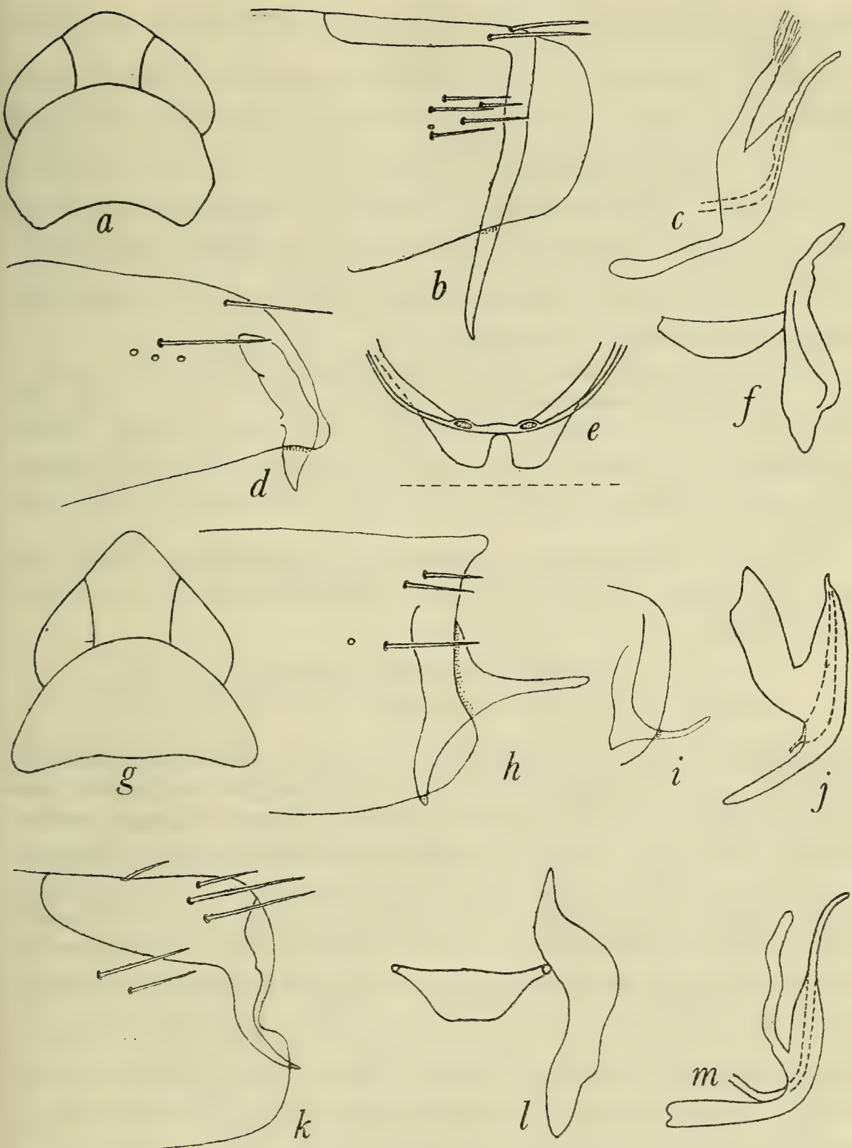

FIGURE 35.—*Protalebrella.* *a–f, P. brasiliensis: a*, anterior dorsum (paratype); *b*, pygofer, lateral aspect (specimen from Havana, Cuba); *c*, aedeagus, lateral aspect; *d*, pygofer, lateral aspect (specimen from Belém, Pará, Brazil); *e*, sternal abdominal apodemes (broken line represents conjunctiva); *f*, style and connective, dorsal aspect. *g–j, P. conica: g*, anterior dorsum; *h*, pygofer, lateral aspect (specimen from Branford, Fla.); *i*, apex of pygofer (specimen from Sierra Rangel, Cuba); *j*, aedeagus, lateral aspect. *k–m, P. iris* (type): *k*, pygofer, lateral aspect; *l*, style and connective, dorsal aspect; *m*, aedeagus, lateral aspect.

narrowly, and a spot on each side at midlength, paler. Forewing markings and venter as in *P. brasiliensis*.

A single specimen in the U. S. National Museum from Sierra Rangel (1,500 ft.), Cuba, was examined and found to have slight differences in the shape of the pygofer and its processes (fig. 35,*i*) and in the dorsal aedeagal apodeme, which was narrower than in typical members of this species. A form from several localities in Panama and the Canal Zone differs from the typical form in that the dorsal ramus of the pygofer process is curved slightly caudodorsad. It seems advisable to leave these forms undescribed until the degree of intraspecific intergradation can be established.

The holotype, a female from El Naranjo, San Luis Potosí, Mexico, is in the Snow Entomological Collections. A topotypic male, not mentioned in the original description, has been studied. Other specimens have been examined from Branford and Sanford, Florida; Brownsville, Texas; Cordoba, Mexico; and Santa Ana and El Cacao, Costa Rica.

This species superficially resembles *P. brasiliensis* and has been included under that name in some collections and in some older descriptions.

Protalebrella iris, new species

FIGURE 35,*k–m*

Length of male 3.6 mm., of female 3.7 mm. Head well produced but with apex broadly rounded, crown with median length less than one-fourth greater than interocular width. Pronotum large, median length more than one-half greater than median length of crown; wider than head including eyes. Forewing unusual in the genus in that width of broadest anteapical portion of cell M is greater than that of cell R, and in that the fork of vein M occurs at point opposite the apical half of the inner apical cell; apical margin slightly falcate. Ocelli as in *P. brasiliensis* (Baker). Female seventh sternum triangular, well produced, the apex angulate. Male plates with a single row of macrosetae. Pygofer with posterior margin weakly bilobed; pygofer process arising along posterior pygofer margin, short, gradually tapered, vertical near base, curved slightly caudoventrad in apical portion. Style short, without preapical lobe, in lateral aspect bisinuate, the apical portion tapered to acute tip which is curved slightly ventrad. Connective in form of cross-bar. Aedeagus similar to that of *P. brasiliensis* but with longer preatrium. Sternal abdominal apodemes not traversing one conjunctiva.

Ground color of crown and pronotum sordid yellow, an indistinct median longitudinal vitta on crown and two similar parallel longitudinal vittae on pronotum, dull orange. Scutellum gray, the median

line, an intersecting, transverse anteapical vitta, a spot on each margin opposite end of transverse sulcus, dull ivory. Forewings with ground color milky opaque, an inverted sagittate marking on basal region to the claval apex, beginning as a bright orange vitta parallel to anal margins, becoming narrowly bordered externally with black near its base, extending caudad and widening along commissure, intersecting midlength of claval suture and extending laterad on both wings to costal plaque, thence caudomesad to claval apex, the internal portion of "head" of the arrow and an adjoining short area more basad along commissure, translucent, marked with dark gray dots and vermiculations, apex from claval apex to basal half of outer apical cell and all region more distad except paler extreme apex, fumose, with pale areoles in apex of cell M and in disc of outer apical cell. Venter entirely pale.

Holotype male and allotype female, Rio Caraguata, Mato Grosso, Brazil (F. Plaumann), in Snow Entomological Collections, University of Kansas.

Protalebrella terminata (Baker)

FIGURE 36,*a–c*

Protalebra terminata Baker, Psyche, vol. 8, p. 404, 1899.
Protalebrella terminata; Young, Univ. Kansas Sci. Bull. 35, p. 39, 1952.

Length of male 3.2 mm.; of female 3.2–3.6 mm. Head well produced but with apex broadly rounded; median length about one-fourth greater than interocular width. Pronotum with median length slightly less than one-half greater than median length of crown; width exceeding width of head including eyes. Ocelli as in *P. brasiliensis* (Baker). Female seventh sternum large, hind margin strongly produced medially, the apex acute or sharply rounded. Male plates each with a double row of macrosetae through most of length. Male pygofer in lateral aspect with posterodorsal margin shallowly concave, posteroventral margin extended ventrad in a short rounded lobe; pygofer process arising dorsally on posterior margin extending mesad, thence caudolaterad, gradually tapered throughout its length to acute apex which greatly exceeds posterior pygofer margin in lateral aspect. Style short, in lateral aspect bisinuate, the apex acute and directed posteroventrad, preapical lobe absent. Connective and aedeagus as in *P. brasiliensis*, but aedeagus with elongate preatrium and with shaft gradually tapered from base to apex. Sternal abdominal apodemes as in *P. brasiliensis*.

Ground color of crown, pronotum and scutellum dull yellowish white, of forewings, golden, a narrow median vitta on apical half of crown, a U-shaped marking on anterior two-thirds of pronotum and

occasionally a lateral vitta on each side of this, a bisinuate vitta in basal third and a pair of parentheses-like arcs near midlength of clavus, a dot near base, a V-shaped vitta in basal third, an irregular lobate vitta at midlength on mesal half (often wanting) and two strongly undulate transverse vittae in apical half of corium, orange. Apical cells variously and irregularly marked with black, frequently with several paler areoles outlined. Venter entirely pale.

In a pale variety of this species, the undulate markings of the forewings are narrow and pale gray, instead of orange.

The type, a male from Chapada, Brazil, is in the U. S. National Museum. Specimens have also been examined from Rio Caraguata, Mato Grosso, Brazil; Campinas, Brazil; Villarica, Paraguay; and Provincia del Sara, Bolivia.

Protalebrella parana, new species

FIGURE 36,*d–g*

Length of male 3.0 mm. Head distinctly produced with apex broadly rounded; crown with median length one-fourth greater than interocular width. Pronotum wider than head including eyes, with median length one-third greater than median length of crown. Ocelli slightly closer to median line of head than to inner margins of eyes. Male pygofer with a weakly developed process along ventral margin, and a double process arising along posterior margin, the double process consisting of an outer, short, curved process that is bifid apically and an elongate inner process that is directed ventrad. Style without distinct preapical lobe. Connective transverse, strongly joined to aedeagus. Aedeagus with preatrium short, shaft abruptly narrowed on anterior margin before apical fifth which is slender and slightly arcuate. Sternal abdominal apodemes not tranversing one conjunctiva.

Crown dull gray with a faint orange median discal spot. Pronotum lacteus with a pair of longitudinal orange vittae, broadened and approximate near anterior margin, extending to posterior margin. Scutellum chalky with basal angles darker. Forewing milky-translucent, an oblique vitta in base of clavus parallel to lateral margin of scutellum, an arcuate transcorial vitta in basal third, an undulate transverse vitta extending from midlength of costa caudomesad to claval suture, thence cephalad to midlength of clavus and mesad to commissure, and an oblique vitta from inner basal angle of outer apical cell through anteapical portions of cells R and M but not into apex of clavus, orange; apical cells faintly fumose except an areole near midlength of inner cell, and central portion of outer cell. Face and venter pale yellow; anterior coxae and hind tibiae at apices, orange.

Holotype male, from Jabaty, Para, Brazil, May 1924 (F. X. Williams), in collection of Hawaiian Sugar Planters Association.

***Protalebrella panamensis*, new species**

FIGURE 36,*h–k*

Length of male 3.0 mm. Crown produced, triangular, the apex narrowly rounded, median length one-fourth greater than interocular width. Pronotum wider than head including eyes, with median length

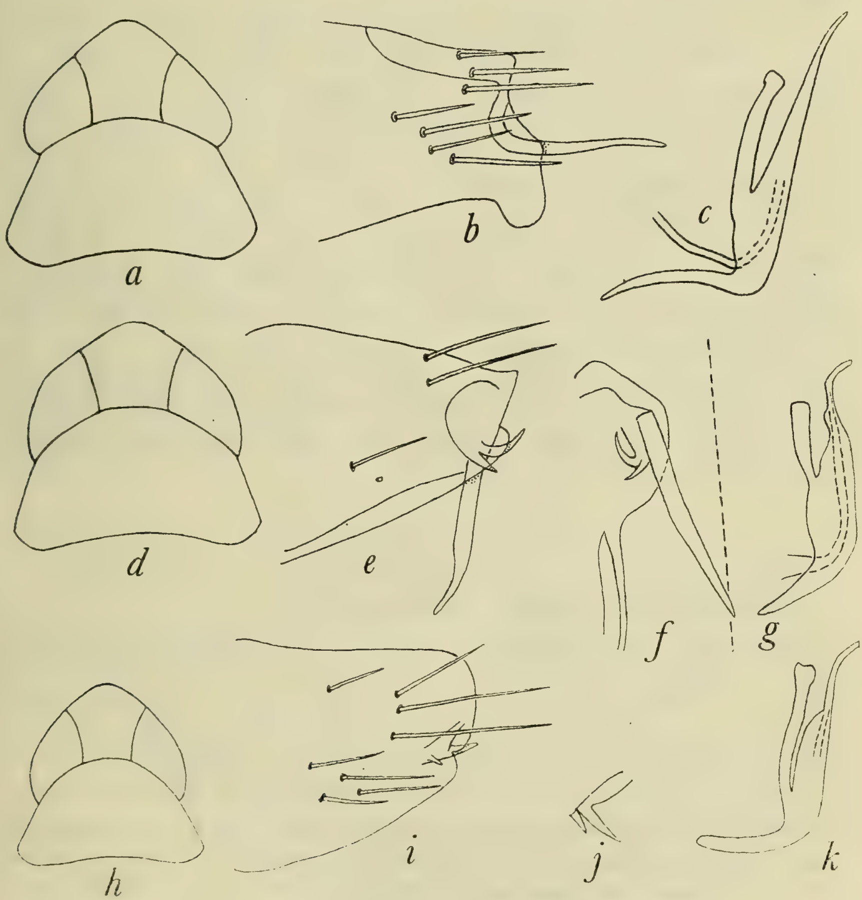

FIGURE 36.—*Protalebrella*. *a–c*, *P. terminata* (type): *a*, anterior dorsum; *b*, pygofer, lateral aspect; *c*, aedeagus, lateral aspect. *d–g*, *P. parana* (type): *d*, anterior dorsum; *e*, pygofer; lateral aspect; *f*, pygofer apex, left side, caudoventral aspect (broken line represent, midline of specimen); *g*, aedeagus, lateral aspect. *h–k*, *P. panamensis: h*, anterior dorsums *i*, pygofer, lateral aspect; *j*, pygofer process, ventrolateral and slightly caudal aspect; *k*, aedeagus, lateral aspect.

one-half greater than median length of crown. Forewing obliquely truncate apically; second apical cell slightly more than half length of inner apical cell; third apical cell short-petiolate. Female seventh sternum with hind margin convex on both sides of slightly produced median portion. Male pygofer with posterior margin broadly rounded, slightly notched at origin of pygofer process near midlength of posterior pygofer margin; pygofer process short, extended caudomesad, with a short basal tooth. Connective a transverse bar. Aedeagus with shaft shorter than dorsal apodeme, abruptly narrowed near midlength.

Crown brownish (probably result of post-mortem change). Pronotum yellowish white. Scutellum dull yellow tinged with darker in basal angles and anteapically. Forewing hyaline, an undulate, transverse marking near base, narrowing towards commissure, translucent pale yellow margined with dark, and a similar broader transverse band attaining commissural margin in apical third of clavus; an irregular marking beginning in apex of cell R and outer apical angle of cell M extending distad through basal half of second apical cell and extending slightly into adjoining apical cells, broadening apically to form a transverse band across inner apical cell and to fill most of third apical cell, smoky. Face and venter pale.

Holotype male, Río Hato, Coclé Province, Panama, Nov. 9, 1951 (F. S. Blanton), in U. S. National Museum (No. 62688), and an additional pair from same locality. One additional male examined from Pesé, Herrera Province, Panama.

Barela, new genus

Figures 37, 38

Type of the genus, *Protalebra decorata* Osborn.

Hind wing with submarginal vein confluent with apical wing margin; posterior branch of vein R entire apically; vein Cu_2 confluent with submarginal vein at point basad of vein m-cu. Forewing with appendix not extending around apex which is smoothly rounded; inner apical cell distinctly wider in basal than in apical half; second apical cell variable interspecifically; third apical cell triangular, usually stalked; outer apical cell longer than broad, not attaining apical wing margin, its base distinctly proximad of base of third apical cell; color markings orange, greenish, or smoky. Male plates elongate, triangular, attaining or exceeding posterior pygofer margin. Pygofer in lateral aspect with posterodorsal margin produced and rounded, disc with a vertical group of irregularly arranged macrosetae on apical half; pygofer process arising near middle of disc or along ventral pygofer margin. Ninth tergum with or without a tergite, if present not delimited posteriorly by integumental thickening.

Anal processes weak, not extending ventrad beyond middle of disc of pygofer. Style simple, not greatly elongate, preapical lobe occasionally present but not strongly developed. Connective triangular or papilioniform. Aedeagus with preatrium elongate; dorsal apodeme usually long and slender; shaft long, slender, without processes. Head not strongly produced, apex rounded in dorsal aspect; crown with median length equal to or less than interocular width; ocelli on rounded margin between crown and face, usually about equidistant from inner eye margins and median line of head. Pronotum at least one-half longer than median length of crown, wider than head including eyes; lateral margins strongly divergent posteriorly.

Distribution: Mexico, Jamaica, and Central America. In addition to the species included in the key below, *Protalebra apicalis* Van Duzee (Bull. Buffalo Soc. Nat. Sci., vol. 8, p. 74, 1907) appears to belong to this genus. A female paratype from Mandeville, Jamaica, was examined from the collections of the California Academy of Sciences.

Barela is closely related to *Protalebrella* and *Diceratalebra*, distinguishing characters for which have been discussed under the respective generic treatments. It is also closely related to *Beamerulus*, of which specimens are larger, possess a zigzag pattern on the forewings, have anal processes extending almost to ventral pygofer margin, and a ninth tergite delimited posteriorly by integumental thickening; all of these features in contrast to *Barela*.

Key to species of *Barela*

1. Crown dull yellow to sordid gray; male pygofer with process elongate, in lateral aspect directed caudodorsad . . . . **decorata** (Osborn)
   Crown with distinct markings, or with an orange tint, male pygofer process not as above 2
2. Forewings marked with angular orange vittae; ninth tergite present; male with pygofer process longer (fig. 37,*h*) . . . **aureocosta** (Ruppel and DeLong)
   Forewings marked with green or black; ninth tergite absent; male pygofer process shorter (fig. 37,*j*; fig. 38,*b*) 3
3. Chief color markings of dorsum yellowish orange and yellowish green; forewing with third apical cell long-petiolate; aedeagus with preatrium elongate. **parvisaccata,** new species
   Chief color markings of dorsum black; forewing with third apical cell not petiolate; aedeagus with preatrium short . . . . **sobrina** (Ruppel and DeLong)

***Barela decorata* (Osborn), new combination**

FIGURE 37,*a–e*

Protalebra decorata Osborn, Ann. Carnegie Mus., vol. 18, p. 255, 1928.
Protalebra sabana Osborn, op. cit., p. 259, new synonymy.

Length of both sexes usually 3.3 mm. Head slightly produced; crown with median length about equal to interocular width. Prono-

tum with median length one-half greater than median length of crown. Forewing with length of second apical cell measured along its inner margin equal to two-thirds length of inner apical cell; third apical cell not petiolate. Female seventh sternum not greatly produced; posterior margin with a median, very short quadrate projection; pygofer with multiseriate white macrosetae each side of ovipositor, and conspicuous tuft of black macrosetae beyond midlength. Male plates not exceeding posterior pygofer margin; each with an irregularly arranged close-set group of black spatulate macrosetae at midlength. Male pygofer with processes slender, elongate, acute apically, arising along ventral pygofer margin, in lateral aspect extending dorsocaudad, not strongly curved, not attaining posterodorsal pygofer margin; in ventral aspect the two processes extending dorsomesad, contiguous apically. Ninth tergum with tergite bounded laterally, but not apically, by integumental thickenings. Anal process present, not attaining middle of disc of pygofer. Style without distinct preapical lobe, short, rounded apically. Connective papilioniform. Aedeagus with preatrium elongate, slender; dorsal apodeme elongate, slender, more than half length of shaft, expanded apically, the expansion with three small lobes in lateral aspect; shaft very elongate, slender, weakly bisinuate, acute apically. Sternal abdominal apodemes traversing one conjunctiva.

Crown pale yellow to sordid gray. Pronotum ivory with a crescentiform orange-red marking extending between humeral margins attaining anterior margin behind eyes but not between eyes. Scutellum yellow, apex black. Forewing hyaline, an orange vitta of irregular width in basal half of clavus joining apically the expanded apical portion of an orange corial vitta that begins at base of costa, extends along costa for short distance, then parallel to claval suture to near midlength, the coalesced apical portions forming the anterior margin of an oblique hyaline streak extending caudolaterad from commissure behind midclavus, not attaining costal margin, the streak also bordered posteriorly with orange; clavus with white anteapical spot; an oblique streak in costal cell near midlength, base of outer apical cell narrowly, and base of third apical cell broadly, black; bases of first and second apical cells and apices of veins R, M and Cu orange broadly bordered with smoky, claval apex black; wing apex hyaline. Face, venter and legs pale except black mesosternal area; pleural portion of pronotum with a pink spot.

The type, from Los Amates, Guatemala, is in the Ohio State University collection. A topotypic male paratype has been examined through the kindness of Dr. J. N. Knull of Ohio State University. Additional specimens have been examined from San Pedro de Montes de Oca, Costa Rica; Cuernavaca, Morelos, Mexico (on *Eupatorium*

adenophorum); Jacala, Mexico; and Socorro Island (2,000 ft.) in the Revilla Gigedo group, Mexico.

Protalebra sabana is placed in synonymy, above, because the only two males examined from Panama appear to be referable to this species. They are from Tocumen, Panamá Province, and agree well with the above description except for two features: the length is 2.8 mm., and the pygofer processes are not quite as gradually tapering; i. e., they are slightly broader anteapically.

The form of the pygofer process, the near-distinct ninth tergite in the male, and the occurrence of the black macrosetae on the male plates are characters indicating that *B. decorata* is more closely related to species of *Beamerulus* than are other species of *Barela*.

Barela aureocosta (Ruppel and DeLong), new combination

Figure 37,*g–i*

Protalebra aureocosta Ruppel and DeLong, Ohio Journ. Sci., vol. 53, p. 227, 1953.

Length of male 3.3–3.4 mm., of female 3.5 mm. Head slightly produced; crown with median length about one-fourth less than interocular width; posterior margin smoothly shallowly concave. Pronotum with median length more than one-half greater than median length of crown. Forewing with length of second apical cell measured along its inner margin less than two-thirds greatest length of outer apical cell; third apical cell long-petiolate. Female seventh sternum with posterior margin broadly convex, not greatly produced; pygofer without conspicuous tuft of black macrosetae. Male plates slightly exceeding posterior pygofer margin, each with a single longitudinal row of pale macrosetae from near base to apex; without conspicuous black macrosetae. Male pygofer with process arising near center of disc, slender, tapered, extending caudomesad, thence curved caudodorsad, not exceeding posterior pygofer margin, the two processes subparallel in ventral aspect. Ninth tergite indistinct, weakly delimited laterally. Anal process present, not attaining middle of disc of pygofer. Style widened anteapically, but without distinct preapical lobe, apex sharply rounded. Connective broad, triangular. Aedeagus with preatrium slender; dorsal apodeme slender, elongate, more than half length of shaft, slightly expanded apically in cephalic aspect; shaft slender, cylindrical, elongate. Sternal abdominal apodemes not traversing one conjunctiva.

Crown with ground color dull ivory to gray, an irregular, transverse interocular line across disc pale yellow to dull red. Pronotum with ground color gray, a transverse, broad dull red stripe across anterior portion of disc with a caudolateral extension on each side to humeral margins. Scutellum dull yellow, the extreme apex paler. Forewing

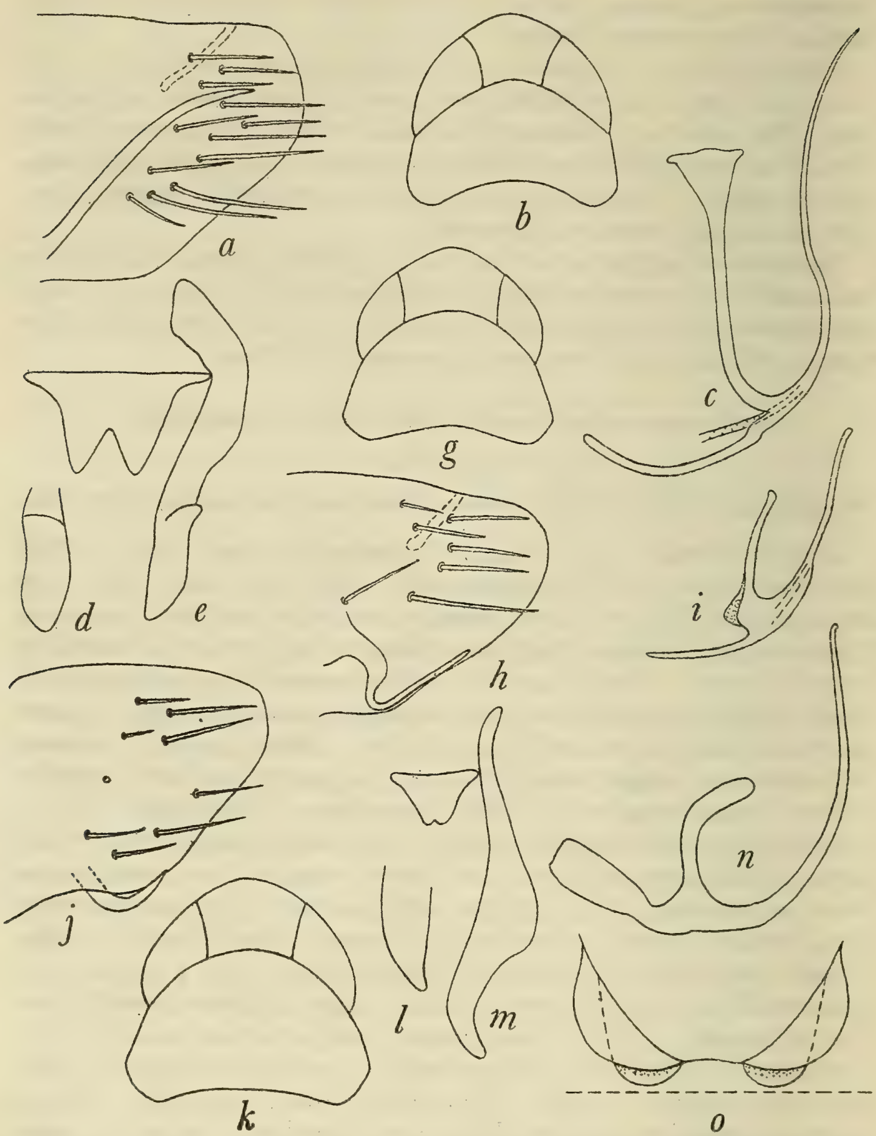

FIGURE 37.—*Barela. a–e, B. decorata: a*, pygofer, lateral aspect; *b*, anterior dorsum; *c*, aedeagus, lateral aspect; *d*, style apex, broadest aspect; *e*, style and connective, dorsal aspect. *g–i, B. aureocosta: g*, anterior dorsum ; *h*, pygofer, lateral aspect; *i*, aedeagus, lateral aspect. *j–o, B. parvisaccata: j*, pygofer, lateral aspect; *k*, anterior dorsum; *l*, style apex, dorsal aspect; *m*, style and connective, dorsal aspect; *n*, aedeagus, lateral aspect; *o*, sternal abdominal apodemes, ventral aspect. (In *a* and *h* the broken lines represent the anal process; in *o*, the conjunctiva.)

with ground color of basal two-thirds dull orange fading to yellow along costal margin, clavus with base, a spot near inner basal angle, one at midlength and an anteapical spot, corium with spot near base, a spot near midlength involving cell M and brachial cell and an elongate costal spot which is bordered with black, anterior to outer apical cell, yellow to hyaline; an areole in apex of cell R and cell M and in outer apical cell, hyaline, remainder of wing apex smoky, the yellow apical veins strongly bordered with darker. Clypeus and clypellus yellow, with a transclypeal narrow band just below ocelli, dull red; lora, genae and pleural portion or pronotum pale gray, the last with a pink spot; mesosternum black; remainder of venter and legs pale except apical half of each male plate which is darker along mesal margin.

The holotype male, from Iguala, Guerrero, Mexico, in the D. M. DeLong collection, has been examined. Additional specimens have been examined from Chilpancingo, the Cuernavaca-Acapulco Road, and Cuernavaca (on *Eupatorium adenophorum*), Mexico, and from Santa Tecla, El Salvador (on *Lantana camara*). The species has been collected in numbers from the latter host plant by N. L. H. Krauss.

In some males examined from El Salvador, the shaft of the aedeagus in lateral aspect is more abruptly narrowed than in typical specimens.

From *B. decorata* (Osborn), which it resembles superficially, *B. aureocosta* may be easily distinguished by its petiolate third apical cell in the forewings and its lack of conspicuous black macrosetae on male plate or female pygofer, in addition to the characters given in the key.

Barela parvisaccata, new species

Figure 37,*j–o*

Length of male 3.8 mm., of female 3.8–4.0 mm. Head slightly produced; crown with median length slightly more than half interocular width. Pronotum with median length more than twice median length of crown. Forewing as in *B. aureocosta* (Ruppel and DeLong). Ocelli closer to inner margins of eyes than to median line of crown. Female seventh sternum with posterior margin broadly convex, with a small angular median excision; pygofer with multiseriate microsetae at each side of ovipositor. Male plates attaining posterior pygofer margin, each with single row of macrosetae from near base to apex. Male pygofer process arising near ventral margin, short, sinuate, extending ventromesad, thence curved caudodorsad, the two processes widely separated in caudal aspect. Ninth tergite wanting. Anal processes membranous. Style with distinct preapical lobe, the apical extension slightly decurved. Connective papilioni-

form. Aedeagus with preatrium about as long as dorsal apodeme, broader than in other species of the genus and trough-like; dorsal apodeme broader than shaft, curved gradually posterodorsad, less than half as long as shaft, which is slender, elongate, and smoothly curved dorsad. Sternal abdominal apodemes not traversing one conjunctiva.

Crown entirely greenish gray to ivory with a poorly defined, interocular transverse yellow streak. Pronotum with ground color dull gray, a transverse broad stripe across anterior portion of disc with a caudolateral extension on each side to humeral margin, dull red to yellow. Scutellum entirely olive green to dull yellow. Forewing with ground color pale green almost to claval apex, a small axillary spot, a transcommissural, transversely oval claval spot just behind scutellar apex, a transcommissural transverse line between claval sutures at midclavus; an oblique corial dash along claval suture near base, costal plaque, an oblique marking through cells R and M near midlength of wing and an areole anterior to base of each of apical cells, hyaline; wing apices smoky with a hyaline arc through inner apical cells. Face yellow to green, in some specimens with a faint interocular stripe below ocelli; pleural portion of pronotum usually with an orange spot, mesosternum black, remainder of venter and legs pale yellow to pale green.

Holotype male, allotype, and three paratype females, Cuernavaca, Mexico, July 1953 (N. L. H. Krauss, on *Lantana*), in U. S. National Museum (No. 62689).

Barela sobrina **(Ruppel and DeLong), new combination**

FIGURE 38

Protalebra sobrina Ruppel and DeLong, Ohio Journ. Sci., vol. 53, p. 228, 1953.

Length of male 3.1 mm. Head slightly produced with median length about one-fourth less than interocular width. Pronotum with median length about twice median length of crown. Forewing with length of second apical cell measured along inner margin less than two-thirds length of inner apical cell measured along same vein; third apical cell triangular or very nearly so. Male plates not exceeding posterior pygofer margin, each with a longitudinal row of macrosetae from near base to apex. Pygofer with process arising near center of disc, extending ventrad, curved at ventral pygofer margin and extending dorsocaudad and slightly mesad, in ventral aspect the two processes convergent but distinctly separated apically. Ninth tergite absent. Anal processes present, attaining middle of disc of pygofer. Style with weak preapical lobe, apex sharply rounded. Aedeagus with preatrium short, distinct; dorsal apodeme digitiform,

less than half length of shaft, not expanded apically; shaft nearly straight. Sternal abdominal apodemes not traversing one conjunctiva.

Crown pale yellow, the interocular marking bordering the hind margin and trilobate with the lobes extending anteriorly, the median narrower and longer than the lateral lobes. Pronotum blackish brown. Ground color of scutellum and forewings smoky, median portion of scutellum paler; forewing with a broad marginal costal streak in basal, a similar streak in apical half, ending in basal portion of outer apical cell, and a small wedge-shaped marking in base of third apical cell, yellow; clavus with an indistinct oblique vitta in basal half and an obliquely transverse marking behind midlength; corium with a similar vitta in basal half of brachial cell, a spot near its midlength, a spot before apex of cell M and a transverse marking near midlength of inner apical cell, translucent; veins R and M

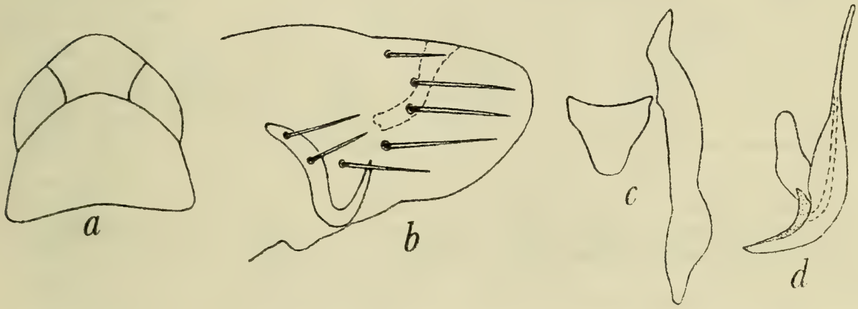

FIGURE 38.—*Barela sobrina* (type): *a*, anterior dorsum; *b*, pygofer, lateral aspect (broken line represents anal process); *c*, style and connective, dorsal aspect; *d*, aedeagus, lateral aspect.

yellow opposite claval apex; disc of outer apical cell hyaline. Face and venter entirely pale yellow, the dorsal portions of the pleural portion of pronotum smoky.

The holotype male, from Iguala, Guerrero, Mexico, has been examined through the kindness of Dr. D. M. DeLong. Other specimens have been examined from Compostela, Nayarit, Mexico, and from Totalapan, Oaxaca, Mexico.

SPECIES OF UNCERTAIN POSITION

Protalebra clitellaria Osborn

FIGURE 39

Protalebra clitellaria Osborn, Ann. Carnegie Mus. vol. 18, p. 257, 1928.

Length of male about 3.1 mm. Head short, triangular; crown with median length one-fourth greater than interocular width. Pronotum

wider than head including eyes, lateral margins strongly divergent posteriorly. Face broadly convex, in lateral aspect strongly divergent from contour of dorsum; ocelli on rounded margin between crown and face, closer to eyes than to median line of head. Male plates triangular with divergent rounded apices, much shorter than pygofer, each with submarginal row of conspicuous flattened macrosetae in third quarter of its length. Pygofer with posterodorsal margin strongly produced, with small group of irregularly arranged macrosetae in upper half of disc; a thickened bar in pygofer wall extending from dorsal margin to near middle of disc; anal process extending to middle of disc. Style without preapical lobe, curved slightly ventrad at apex. Connective semicircular with apex turned dorsad. Aedeagus without

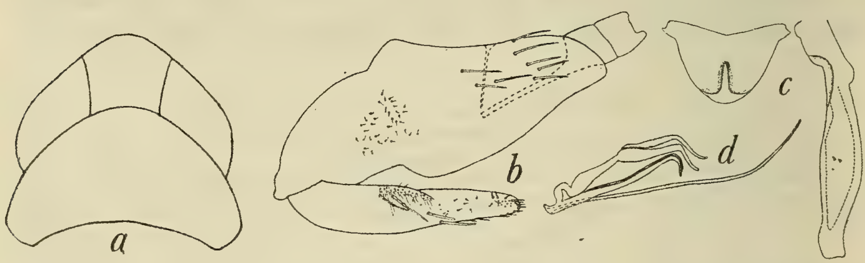

FIGURE 39.—*Protalebra clitellaria* (type): *a*, anterior dorsum; *b*, pygofer, lateral aspect; *c*, style and connective, dorsal aspect; *d*, aedeagus, lateral aspect.

preatrium; dorsal apodeme Y-shaped, sigmoid at base, the arms as long as the unpaired portion and decurved apically; a pair of elongate atrial processes extending beneath dorsal apodeme, each slender and tapering to acute apex which is decurved; shaft simple, setiform, twice as long as atrial processes.

Ground color of crown sordid yellowish gray. Pronotum burnished orange with a pair of black spots along posterior margin. Scutellum black suffused with golden, basal angles narrowly outlined in orange, a pair of spots one behind each apex of transverse sulcus, and the apex, ivory. Forewings transparent yellow; clavus with basal half burnished orange outlined with black except next claval suture; corium with a small, round black spot in brachial cell in basal third; claval apex and portion of adjoining corium fumose (the extent of the fumose marking undeterminable in the damaged type). Face and venter dull yellow.

Known only from the type, a male from Chapada, Brazil.

Specimens with intact wings are needed to determine the generic relationships of the species. The male pygofer, in its setal arrange-

ment and barlike integumental thickenings, and the anal processes suggest a relationship to *Protalebra*, but the aedeagus differs markedly from the species here assigned to that genus and suggests a possible relationship to *Elabra.*

Protalebra sublunata Osborn

Erythroneura sublunata Osborn, Ann. Carnegie Mus., vol 18, p. 289, 1928.
Protalebra sublunata; Young, Univ. Kansas Sci. Bull. 35, p. 38, 1952.

Length of female 2.6 mm. Crown strongly produced with apex rounded; median length more than half greater than interocular width. Pronotum wider than head including eyes; median length about one-fourth greater than median length of crown; lateral margins strongly divergent posteriorly. Forewing without confluent longitudinal veins before cross veins; appendix not extending around wing apex; inner apical cell much broader at base than at apex; second apical cell narrow, parallel-margined, its length measured along inner margin approximately two-thirds length of inner apical cell measured along same vein; third apical cell triangular, long-petiolate; outer apical cell longer than broad, irregularly pentagonal, not attaining wing apex. Hind wing with submarginal vein confluent with apical wing margin; vein Cu_2 confluent with submarginal vein at point much basad of vein m-cu; veins R and M contiguous anteapically, separate apically. Face broadly convex in profile, slightly divergent from contour of crown; ocelli on rounded margin between crown and face, midway between inner eye margins and median line of head. Female seventh sternum short, transverse, posterior margin concave medially, the lateral lobes slightly produced and rounded; pygofer without conspicuous black setae.

Crown dull ivory, a conspicuous apical spot black, a pair of indistinct discal spots and an indistinct transverse interocular line pale gray. Pronotum orange, the hind margin broadly ivory. Scutellum ivory with apex black. Forewing with ground color dull orange in basal half, a transcommissural marking narrow and rounded at midcorium, much broader in apical half of clavus, ivory bordered with sanguineous, the sanguineous color extending to and expanding along costal margin at its midlength; a spot at base of brachial cell, anterior two-thirds of costal plaque and portion of costal cell anterior to outer apical cell grayish translucent; brachial and anteapical cells apically, appendix and first and second apical cells in their basal two-thirds, fumose; third and fourth apical cells margined with black internally. Face and venter entirely dull yellowish gray.

Known only from the type, a female from Fort Principe, Rio Guaporé, Brazil, Aug. 26, 1909, in the Carnegie Museum.

This species has the facies of a *Paralebra.*

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TWO ADDITIONAL MIOCENE PORPOISES FROM THE CALVERT CLIFFS, MARYLAND

By Remington Kellogg

I. Rediscovery of *Phocageneus venustus* Leidy

In his article on vertebrate remains from Richmond, Va.,published in 1850, Jeffries Wyman mentioned that among the specimens he had received from Dr. Martin Burton, a resident of Richmond, was a tooth which Professor Louis Agassiz identified as belonging to his genus *Phocodon.* The type of this genus is *Phocodon scillae* Agassiz, now generally recognized as a species of *Squalodon.* Professor Wyman figured and described the tooth received from Dr. Burton, but he did not give it a specific name. Prior to 1869 Leidy received from Professor Wyman what was supposed to be the same tooth, but remarked: "Having requested Prof. Wyman to allow me to inspect the tooth, he sent me a specimen which he observed was either the original of the figure (1850, fig. 4) or pertained to the same animal. If such is the case, the figure is an unfaithful representation of it." This comment is unquestionably correct, for while Wyman's figure represents what appears to be a tooth with a small tubercle or cusp at the base of the crown posteriorly, a vestigial tubercle on the anterior cutting edge, and a flattened root of which the terminal end is missing, Leidy's figure (1869, pl. 29, fig. 10) shows a tooth of a somewhat different appearance.

The tooth (No. 11227) in the collection of the Academy of Natural Sciences of Philadelphia bearing the name *Phocageneus venustus* is, as Leidy has commented, not accurately portrayed in the illustration published by Wyman. Nevertheless it should be noted that the essential structural features are shown, although somewhat exaggerated. After examining this tooth, however, I am of the opinion that it is actually Wyman's original specimen, and that his illustration represents an unsuccessful attempt to draw a rather difficult object. One reason for this conclusion is that the length of Wyman's tooth as illustrated corresponds rather closely to that of Leidy's type specimen. Wyman stated that his tooth measured 1.2 inches, that is, 30.48 mm. Furthermore, Wyman's description applies very exactly to the tooth (No. 11227) in the collection of the Academy of Natural Sciences of Philadelphia. Leidy also accurately described this tooth, and his illustration is of exactly the right size, though the ornamentation of the enamel crown is not accurately depicted. Notwithstanding the observed inaccuracies in the illustrations, the descriptions given by both Wyman and Leidy clearly pertain to the tooth in the collection of the Academy of Natural Sciences of Philadelphia and it is the type of *Phocageneus venustus.*

Wyman's description (1850, p. 231) is as follows:

> This tooth (fig. 4) is 1 2/10 inch in length, having a small portion broken from the end of its root. The crown is conical, compressed on its inner face, with slightly trenchant edges, the posterior of which is provided with a slightly projecting tubercle. The enamel over its whole surface is roughened by small irregular ridges, the general direction of which is from the base towards the apex of the crown, those at the apex being the most minute. This tooth must have been placed at the anterior part of the jaw; all those of the posterior lateral portions being deeply indented.

Wyman obviously was influenced by the assumption that this odontocete was a relative of *Squalodon,* whose posterior teeth have serrated cutting edges. This tooth, however, came from the posterior end of the tooth row and probably from the maxillary.

Leidy (1869, pp. 426–427) described the tooth as follows:

> The crown is conical, compressed, oval in section at base, and moderately curved. It forms an acute ridge before and behind, and has an acute point. The base is conspicuously swollen internally, and contracts all around toward the neck. The anterior acute border of the crown expands in a triangular surface of the swollen base. The posterior border is embraced by an attempt to form a basal cingulum. The enamel of the crown is nearly uniformly corrugated, and the wrinkles are much interrupted. The fang, broken at its point, has been about twice the length of the crown, is conical, slightly curved, and feebly gibbous.

The dimensions of the type tooth of *Phocageneus venustus* are as follows: Maximum length as preserved, 30.4 mm.; maximum height of crown, 13.5 mm.; maximum anteroposterior diameter of base of

crown, 10.7 mm.; maximum transverse diameter of base of crown, 8.8 mm.; maximum diameter of root, 9.5 mm.; maximum diameter of root at broken-off extremity, 8.0 mm.; least diameter at same point, 5.5 mm.

The specimen hereinafter described apparently represents the second recorded occurrence of this extinct porpoise in the Calvert formation. The symphyseal portion of the mandibles was discovered by Roland A. Fowler on May 15, 1955, protruding from the face of the cliff south of Fairhaven, Md., and it was brought to the U. S. National Museum for identification. Subsequently, on May 21, Franklin L. Pearce accompanied Mr. Fowler to the site and excavated the posterior portions of the mandibles as well as six vertebrae. Later, on September 17, Mr. Fowler, Mr. Pearce, G. Donald Guadagni, and I made a deeper excavation at the site and recovered ten additional vertebrae.

Phocageneus **Leidy**

Phocageneus Leidy, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 7, p. 426, 1869.

Genotype: *Phocageneus venustus* Leidy.

Diagnosis: Mandibles with symphysis united but not firmly ankylosed; width of symphysis greater than depth; opposite free posterior portions of mandibles come together at a 30° angle at symphysis; coronoid process robust; distance from apex of coronoid process to posterior margin of hindmost alveola equivalent to approximately one half of distance from posterior face of condyle to posterior end of symphysis; flange-like internal dorsal border of mandible posterior to coronoid process prolonged backward internal to and beyond condyle; condyle large, directed downward and backward, and projecting externally conspicuously beyond outer face of mandible.

Seven teeth located behind posterior end of symphysis on each mandible; alveolae separated by intervals of 4.5 to 11.5 mm.; circular depressions for reception of apices of teeth in upper jaws present between teeth on symphysis; roots of teeth elongated, curved, and slightly expanded proximally; crowns of teeth somewhat compressed transversely on distal half of their height and bent inward toward apex, ovoidal in cross section at base, constricted around circumference at base, and with a vertically directed blunt carina on anterior and posterior faces of at least the nine hindmost teeth; enamel on basal half of crowns of posterior mandibular teeth coarsely corrugated or wrinkled; enamel on crowns of anterior mandibular teeth less noticeably wrinkled, the striae being least conspicuous on external face, and a vertically directed carina more noticeably developed on posterior than on the anterior face.

Periotic with unusually large elliptical fenestra rotunda, relatively small internal acoustic meatus, and elongated anterior process. Cervical vertebrae robust, with relatively thick centra; atlas with reduced lower transverse processes, enlarged upper transverse processes and elongated hypapophysial process; ventroexternal angles of broad transverse processes of third and fifth cervicals project forward and outward; lateral arterial canals large. Neural spines narrow on anterior dorsals and broad on posterior dorsals; first to sixth dorsals have facets for articulation with capitula of corresponding ribs situated at the upper anteroexternal and upper posteroexternal angles of the centra; eighth dorsal with short diapophysis and short parapophysis (transverse process) closely approximated.

Phocageneus venustus Leidy

Phocageneus venustus Leidy, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 7, p. 426, pl. 29, fig. 10, 1869. (See Wyman, Amer. Journ. Sci., ser. 2, vol. 10, 1850, p. 230, fig. 4.)

Type specimen: One tooth. Cat. No. 11227, Academy of Natural Sciences of Philadelphia. Collector, Dr. Martin Burton (1850?).

Horizon and locality: Richmond, Henrico County, Va. Presumably from the diatomaceous deposits, Calvert formation, upper Miocene.

Referred Specimen

USNM 21039: Mandibles, lacking anterior portion of symphysis; right and left tympanic bulla; right and left periotic; right and left malleus; right incus; left stapes; 16 detached teeth; atlas and 3 cervical vertebrae; 10 dorsal vertebrae; 2 lumbar vertebrae; 4 caudal vertebrae; 2 chevron bones; 1 sternal segment; and portions of 5 ribs. Collector, Roland A. Fowler, May 15, 1955.

Horizon and locality: Diatomaceous earth, one-quarter mile south of wharf at Fairhaven, Fairhaven Cliffs, Anne Arundel County, Md., about 8 feet above base of cliff. Calvert formation, upper Miocene.

Mandibles

The anterior portion of the symphysis (pl. 1) was broken off and lost prior to the discovery of these mandibles protruding from the face of the cliff. A short section of the right mandible between the level of the third tooth behind the posterior end of the symphysis and the anterior border of the orifice of the internal dental canal was destroyed accidentally when the specimen was discovered; this region has been restored. The posterior portions of both mandibles are somewhat crushed in a dorsoventral direction but are otherwise

essentially complete. The mandibles were united but not firmly ankylosed at the posterior end of the symphysis. On the ventral face (pl. 2) the line of contact of the opposite mandibles is indicated by a continuous narrow groove which extends medially the full length of this portion of the symphysis.

The symphyseal portion of the united mandibles apparently tapered toward the anterior extremity, since the transverse diameter diminishes from 45 mm. at the level of the posterior end to 28± mm. at the level of the 11th alveola counting forward from the hindmost alveola in the left mandible, although the dorsoventral reduction is less noticeable.

Between the tooth rows the dorsal surface of the symphysis is concave or depressed. Pits for the reception of the apices of the teeth in the upper jaws are present between the teeth on the symphysis.

The distance (107 mm.) from the posterior end of the symphysis to the posterior margin of the hindmost alveola in the left mandible is greater than the interval (60± mm.) between opposite tooth rows at the level of this tooth. The opposite free posterior portions of the mandibles come together at an angle of 30° at the symphysis.

More than 11 alveolae were present in the left mandible when complete. Since there is no known closely related odontocete it is inadvisable to estimate the number of teeth originally present in each mandible. The teeth on the posterior portion of the symphysis were not implanted opposite one another and the alveolae are separated by intervals of 7 to 9 mm. from preceding and succeeding alveolae. The minimum interval between alveolae in either mandible behind the symphysis is about 4.5 mm. The septa between the alveolae are complete. The largest alveola (sixth counting forward from the hindmost) in the left mandible measures 9 mm. anteroposteriorly and 8 mm. transversely, and the smallest (ninth counting forward from the hindmost) 8 mm. anteroposteriorly and 7 mm. transversely. The alveolae located behind the symphysis are larger than those located anterior to the posterior end of the symphysis. The seven alveolae located behind the symphysis on the left mandible are spaced at intervals of 4.5 to 11.5 mm. The distance from the posterior margin of the hindmost alveola to the anterior margin of the 7th alveola in the left mandible is 101.5 mm. The distance between opposite alveolae immediately in front of the posterior end of the symphysis is 22 mm., and at the level of the 11th tooth counting forward from the hindmost in the left mandible it is 18.5 mm. The presence of 7 teeth in the left mandible behind the level of the posterior end of the symphysis readily distinguishes these mandibles from those of *Pelodelphis gracilis* (Kellogg, 1955, pl. 13, fig. 1), which have 12 teeth on this portion of the mandibles.

The extremities of the long roots of at least two teeth posterior to the posterior end of the symphysis curve backward below the tooth immediately behind.

From a lateral view the ventral profile of the proximal portion of the symphysis suggests that the anterior portion was bent slightly upward. The external face of the symphyseal portion of the left mandible is convex along the dorsal border, but then slopes obliquely from the dorsal border to the midline of the ventral surface. A cross section of the symphysis at the level of the 11th tooth counting forward from the hindmost in the left mandible resembles an open U.

The largest nutrient foramen is located on the outer surface of the left mandible 15 mm. below the rim of the second alveola counting forward from the hindmost. A second foramen opens 17 mm. below the rim of the sixth alveola and a third foramen 16 mm. below the rim of the eighth alveola counting forward from the hindmost. Short grooves extend forward from the first and second of these foramina, and a somewhat longer groove extends forward from the third foramen at least beyond the level of the 11th alveola counting forward from the hindmost.

The depth of the left mandible in its present condition at the posteriormost alveola is 32 mm., although crushing has distorted the posterior portion of each mandible to some extent. It is also possible that the posterior portions of the mandibles have been spread apart more than originally existed.

The dorsal edge of each mandible ascends gradually to the apex of the coronoid process which has a thickened dorsal border. Each coronoid process is bent outward and the opposite processes are separated by an interval of 132 mm. The distance (173 mm.) from the apex of the coronoid process to the posterior margin of the hindmost alveola on the left mandible is equivalent to about 53 percent of the distance (324 mm.) from the posterior face of the condyle to the posterior end of the symphysis.

About 52 mm. behind the posteriormost alveola on the inner face of each mandible there is a large orifice for the dental canal. Posterior to this orifice, the inner wall is reduced to a low thin strip along the ventral border of the mandible. The outer wall of the posterior portion of each mandible consists of a thin shell of bone which, judging from the curvature of the crushed areas, was originally somewhat convex. Unlike other odontocetes the dorsal border of the mandible posterior to the coronoid process forms an internal flange-like ledge which is prolonged backward internal to and beyond the condyle. Unfortunately no comparisons can be made with the posterior portions of the mandibles of *Squalodelphis fabianii* (Dal Piaz, 1916) which are concealed by matrix. The ventral margin of the left mandible is

continued backward from the symphysis in a shallow curve toward the angle.

The dorsoventral axis (35 mm.) of the left condyle is directed downward and backward and its external border projects conspicuously beyond the outer face of the mandible. The maximum transverse diameter of the left condyle is 32.8 mm. In outline, the left condyle is almost subscutate in outline and is directed more outward than backward. The right condyle has been restored.

MEASUREMENTS OF MANDIBLES (IN MILLIMETERS)

	Right	Left
Length of mandible, condyle to broken anterior end	395. 0±	386. 0
Greatest length of ankylosed symphyseal portion of rami	62. 5	62. 5
Transverse diameter of mandibular symphysis at level of posterior end	45. 0	
Vertical diameter of mandibular symphysis at level of posterior end	29. 0	
Transverse diameter of mandibular symphysis at level of 11th tooth counting forward from hindmost tooth in mandible	28. 0±	
Vertical diameter of mandibular symphysis at level of 11th tooth counting forward from hindmost tooth in mandible	23. 5	
Height of mandible through coronoid process	85. 0+	87. 0+
Greatest dorsoventral diameter of condyle		35. 0
Greatest transverse diameter of condyle		32. 8
11 alveolae in an interval of		164. 0
7 posterior alveolae (first to seventh) in an interval of		101. 5
4 anterior alveolae (eighth to 11th) in an interval of		56. 0
Condyle to posterior end of symphysis	330. 0±	324. 0
Apex of coronoid process to posterior end of symphysis		282. 0

TEETH

Both mandibles were broken off 62.5 mm. in front of the posterior end of the symphysis. Eleven alveolae are now preserved in the left mandible and presumably the same number were present in the corresponding portion of the right mandible. Seven teeth were implanted in the left mandible behind the level of the posterior end of the symphysis. Four teeth are preserved in place in the right mandible; eight teeth and three alveolae are present in the left mandible. The alveolae for the tenth and eleventh teeth in the left mandible counting forward from the hindmost were completely filled with diatomaceous earth. Two of the detached teeth have been allocated to these alveolae. On the right mandible, the alveolae for the ninth, tenth, and eleventh teeth counting forward from the hindmost lack the outer walls since a section of the external shell of this mandible 70 mm. in length and 18 to 20 mm. in width was destroyed.

The teeth of *Phocageneus venustus* resemble most closely those of *Squalodelphis fabianii* (Dal Piaz, 1916, p. 24, figs. 5–8, and pl. 5, figs. 3–18) from the lower Miocene, upper Langhian stage of Belluno, Italy, not only in size but also in the configuration of the crown and the wrinkling of the enamel. Dal Piaz (1916, p. 32) proposed the family Squalodelphidae to include the Italian *Squalodelphis* and the Argentine *Argyrodelphis* [=*Diochotichus*], while others have regarded *Squalodelphis* as either an offshoot of primitive Squalodontidae (Slijper, 1936, pp. 545, 549) or a transitional form between the Squalodontidae and the Ziphiidae. Although the family allocation of *Phocageneus* will await discovery of a skull, the structural characteristics of the teeth nevertheless indicate some relationship with *Squalodelphis*.

Fifteen teeth were present in each mandible and on each side of the rostrum of *Squalodelphis fabianii*, a total of 60 teeth. The alveolae on the symphysis of *Squalodelphis fabianii* are separated by intervals that progressively increase from 15 mm. at the level of the posterior end to about 23 mm. at the anterior end. On the basis of the illustrations of the skull and mandibles of *Squalodelphis fabianii* published by Dal Piaz (1916, pl. 1, fig. 2; pl. 2, fig. 2) it would appear that eight teeth were located on the symphyseal portion of each mandible and seven on the free portion behind the symphysis. Consequently the eight teeth implanted on the symphyseal portion of each mandible occupied an interval of about 246 mm. Since the four alveolae on the posterior symphyseal portion of each mandible of *Phocageneus venustus* occupy an interval of 62.5 mm., it is obvious that either the symphysis of *Phocageneus* was shorter than that of *Squalodelphis* or a greater number of teeth were present.

The ornamentation of the enamel crowns of the teeth of *Phocageneus venustus* is quite unlike those of either *Delphinodon dividum* (True, 1912, pl. 26, figs. 1–20) or *Tretosphys gabbii* (Kellogg, 1955, pls. 20, 21). Furthermore the teeth of *Phocageneus venustus* are larger than the corresponding teeth of either *D. dividum* or *T. gabbii*. The teeth of *P. venustus* differ from the corresponding teeth of *D. dividum* and *T. gabbii* in that the base of the crown is constricted around its circumference to conform to the shape of the neck of the root and in that the wrinkles or vertical striae on the corrugated enamel surface are more or less complicated by a varying number of short oblique grooves. The enamel on the crown is black.

It should be pointed out that the genotype of the genus *Delphinodon* was fixed by Hay (1902, p. 591) as *Delphinodon mento* (Leidy, 1869, pl. 30, figs. 7, 8). The type tooth of *Delphinodon mento* (No. 11228, Acad. Nat. Sci. Philadelphia) is much larger than those of either *Delphinodon dividum* or *D. leidyi* (Leidy, 1869, pl. 30, fig. 12) and

presents several important peculiarities not shared by the smaller species. When either a skull or mandible with teeth that match the type tooth of *Delphinodon mento* is found, it is quite probable that it will be necessary to separate *D. dividum* generically from *D. mento.*

The ornamentation of the enamel on the inner surface of the crown is rugose to a varying degree, the corrugation or wrinkling of the enamel being most pronounced on the teeth situated behind the symphysis and progressively diminishing anteriorly. The rugosities on the external face of the crown of some of the posterior teeth, although rather coarse, are less prominent as compared to the internal face and are best developed on the basal one-half of this face. The apical one-third of the external face is much less noticeably wrinkled. On the basal half, the internal face of the crown of the first to ninth teeth (counting forward from hindmost) is noticeably roughened by the presence of more or less vertically directed coarse irregular wrinkles. The distal third of the internal face of the crown is less noticeably corrugated. The crown of each of the above-mentioned teeth is somewhat compressed transversely on the distal half of its height and bent inward toward the apex, ovoidal in cross section at the base, and characterized by a vertically directed blunt carina on the anterior and posterior cutting edges. These teeth (pl. 3, figs. 4–6; pl. 4, figs. 1–6) are larger than the corresponding teeth of *Delphinodon dividum* (True, 1912, pp. 171–174, pl. 19, figs. 1–2; pl. 26, figs. 1–20), the sculpturing of the internal enamel surface is relatively coarse (corrugated or wrinkled) on the basal half of their height, no denticulated carina is developed on either the anterior or the posterior faces, and no discernible accessory tubercle is present near the base of the posterior face on any of the mandibular teeth. No minute tubercle is present at the base of the crown either anteriorly or posteriorly on the nine mandibular teeth counting forward from the hindmost. The anterior vertically directed carina extends from the triangular basal area to the apex of the crown. The posterior vertically directed carina is more noticeably developed on the teeth situated behind the level of the posterior end of the symphysis than on the teeth situated anterior to this end of the symphysis. The anterior and posterior faces of first to fourth teeth (counting forward from the hindmost) in the left mandible and the posterior face of the fifth and sixth in the right mandible were worn by occlusion with the teeth in the maxillaries. The presence of circular depressions between the alveolae for the sixth to eleventh teeth in the left mandible indicates rather conclusively that the points of the corresponding maxillary teeth were thrust into these pits.

By "basal cingulum" Leidy (1869, p. 426) apparently referred to the inwardly projecting irregular rugose area (pl. 3, fig. 2) approximately

4 to 5 mm. above the base of the crown on the type specimen of *Phocageneus venustus*. The enamel in this area is corrugated and the more or less vertically directed wrinkles are not in each instance continuous. In describing this tooth Wyman (1850, p. 231) mentions "a slightly projecting tubercle." Wyman seems to have applied this term to a minute tubercle situated near the basal end of the posterior carina on the crown (pl. 3, fig. 2). Since the wrinkles on the enamel surface of the crown of the type tooth are less pronounced than on the posterior mandibular teeth of USNM 21039, this type tooth is tentatively identified as a posterior tooth from the right maxillary.

The following detailed descriptions of 10 of the 16 detached teeth, which were recovered from the matrix enveloping the mandibles, are given to indicate the extent of variation in the ornamentation of the enamel on the crowns. The allocations are based on comparison with teeth implanted in the mandibles.

A posterior tooth (pl. 4, fig. 2), identified as the second counting forward from the hindmost on the right mandible, which lacks the distal portion of the root, has the enamel on all faces of the crown coarsely corrugated on the basal half, the apical half of the crown is compressed transversely, the edge of the vertical carina on the anterior face is blunt and slightly nodular, and the base of the crown is constricted around its circumference.

Another posterior tooth (pl. 3, fig. 6), identified as the fourth counting forward on the right mandible, has carinae on the anterior and posterior faces, the apical half of the crown is bent inward and somewhat compressed transversely, the enamel on the basal half of the crown is corrugated or wrinkled, and the base of the crown is constricted around its circumference. The greatest diameter of the proximal portion of the elongated curved root exceeds slightly the greatest diameter of the basal portion of the crown.

The sixth tooth (pl. 3, fig. 5), counting forward from the hindmost on the left mandible, has the enamel on the crown ornamented similarly to that of the preceding tooth but differs in having two carina on the anterior face, the bifurcation commencing approximately 3 mm. below the point.

An anterior tooth (pl. 4, fig. 1), presumably the 10th in the left mandible counting forward from the hindmost, is quite similar to the 11th (28.2+ mm.) as regards ornamentation of the enamel on the crown, although the anteroposterior diameter of the crown is greater and a vertical carina is present on both the anterior and posterior faces.

The anterior tooth (pl. 4, fig. 6) identified as the 11th counting forward from the hindmost in the left mandible has the enamel on the internal face somewhat wrinkled, especially at the base of the crown, but possesses a carina on the anterior edge which bifurcates

ventrally to bound a rather smooth triangular basal area. The posterior face of the crown is worn.

Another anterior tooth (pl. 3, fig. 4) from the right mandible which seems referable to the 11th counting forward from the hindmost has an ornamentation on the internal face of the crown similar to the corresponding tooth from the left mandible.

Another detached tooth (pl. 4, fig. 5) apparently was located anterior to the 11th alveola and may be either the 12th or the 13th in the tooth row of the right mandible. It has an inwardly curved crown which is tapered toward the point. The side to side compression of the upper half of the crown is much less noticeable than on the 10th tooth. On the internal face of the crown the enamel is faintly wrinkled, the striae extending in a more or less vertical direction to the point. As contrasted with the internal face, the enamel on the external face is less noticeably wrinkled and relatively smooth. A slight vertical carina is present on the posterior face but not on the anterior face. The elongated and curved root is swollen on the internal face below the crown, and slightly flattened transversely at the extremity.

A rather small tooth (pl. 4, figs. 3, 4) with shortened and malformed root unquestionably represents the posteriormost tooth in either the upper or lower tooth rows. No alveola for such a tooth is discernible on the left mandible, but since this portion of the right mandible was destroyed, it may possibly have been present in the right tooth row. In that case, eight teeth were present in the right mandible behind the posterior end of the symphysis. The crown is low—the height being equivalent to about two-thirds of the anteroposterior diameter—and is constricted at the base, the apex of the crown is blunt and a coarsely corrugated pseudocingulum, broader internally than externally, sets off the somewhat triangular apical half of the crown. The short root is transversely flattened, nodular on the distal half, and irregularly bifurcated at the extremity.

Of these 16 detached teeth, the longest one is complete and undoubtedly belongs in the anterior part of the tooth row of either the upper or lower jaws. The measurements of this slender tooth are as follows: Greatest length, 39 mm.; greatest length of root, 29 mm.; greatest diameter of root, 8 mm.; height of crown, 12 mm.; greatest anteroposterior diameter of crown, 7 mm. If this tooth was included in a lower tooth row it was dislodged from the symphyseal portion of the right mandible. The inwardly curved crown is ornamented with rather coarse vertical wrinkles on the inner surface, although the outer surface is relatively smooth. The base of the crown is not constricted around its circumference. The terminal end of the backwardly curved and tapering root is very slender.

MEASUREMENTS OF THE DETACHED TEETH (IN MILLIMETERS)

	L. 6 (pl. 3, fig. 5)	R. 4 (pl. 3, fig. 6)	R. 11 (pl. 3, fig. 4)	R. 12 or 13 (pl. 4, fig. 5)	L. 11 (pl. 4, fig. 6)	R. 2 (pl. 4, fig. 2)	L. 10 (pl. 4, fig. 1)	R. P. (pl. 4, fig. 3)
Greatest length, as preserved	36. 8	34. 5	32. 8	30. 8	28. 2	26. 0+	24. 5+	11. 5
Greatest length of root	28. 7	25. 2	25. 6	23. 0	16. 8	17. 7+	15. 8+	5. 8
Greatest diameter of root	8. 3	8. 8	7. 2	7. 0	7. 0	8. 0	7. 8	4. 0
Height of crown externally	10. 3	11. 4	10. 6+	12. 0	11. 5	10. 5	11. 0	4. 2
Greatest anteroposterior diameter of crown	8. 6	8. 7	6. 8	6. 9	7. 2	9. 4	7. 7	6. 5
Greatest transverse diameter of crown	7. 7	7. 3	5. 8	6. 6	6. 3	9. 7	7. 2	5. 0

MEASUREMENTS OF THE TEETH IN MANDIBLES (IN MILLIMETERS)

	R. 5	R. 6	R. 7	R. 8	L. 1	L. 2	L. 3	L. 4	L. 5	L. 7	L. 8	L. 9
Greatest length in a straight line	32. 5					32. 0			32. 5			
Greatest length of root in a straight line	22. 0					21. 0			22. 0			
Height of crown externally	11. 5	11. 5	11. 0	10. 5	8. 5	10. 0	11. 7	11. 4	11. 0	11. 0	11. 2	11. 4
Greatest anteroposterior diameter of crown	9. 4	9. 4	8. 5	7. 9	8. 8	9. 35	8. 8+	9. 2	9. 4	8. 2	7. 9	7. 3
Greatest transverse diameter of crown	8. 3	7. 6	7. 4	6. 7	8. 3	8. 3	8. 3	8. 35	8. 1	7. 0	6. 5	6. 4

Another slender detached anterior tooth of similar shape, which lacks most of the crown, measures 37 mm. in its present condition and may, when complete, have exceeded the length of the previously described tooth.

The left mandible was broken subsequent to preparation, revealing the roots of the second and third teeth counting forward from the hindmost. The distal half of the root of the second tooth is bent backward almost at right angles to the axis of the crown and the proximal portion of the root and extends backward below the root of the posteriormost tooth. The distal portion of the root of the third tooth is not bent backward as abruptly as that of the second tooth and its extremity does not extend posterior to the level of the anterior margin of the alveola of the second tooth. In the right mandible the root of the third tooth situated behind the posterior end of the symphysis (presumably the fifth tooth counting forward from the hindmost) is strongly curved backward toward the extremity and slightly expanded below the base of the crown and its extremity extends backward below the root of the tooth behind it.

Periotic

The left periotic (pl. 5, fig. 7), which was detached from the corresponding tympanic bulla, does not differ in its external features from the right periotic. Both periotics are characterized by dorsoventral compression of the pars cochlearis, unusually large orifices of the fenestra rotunda and the aquaeductus cochleae, and a relatively small internal acoustic meatus.

One characteristic feature of the ventral surface of the periotic (pl. 5, fig. 6) is the shape of the articular facet on the posterior process for the corresponding process of the tympanic bulla. This articular facet curves concavely from end to end, and slopes from the posteroexternal angle to the anterointernal angle. Faint shallow grooves directed externally are visible on the internal portion of this facet. The ventrointernal border of the posterior process projects inward and the free edge contributes the floor for the facial canal. The anterior face, except for the short internal portion, and the dorsal face of the posterior process form a continuous sloping surface which terminates in the dorsally prolonged posterodorsal free edge of this process; the posterior face of this process is shallowly concave and the external end is emarginate.

As regards the ventral aspect of the pars cochlearis, there is a much closer resemblance to *Zarhachis flagellator* (Kellogg, 1924, pl. 7, fig. 6) than to other Calvert Miocene porpoises, although the free posterior and internal and anterior faces of this region are thicker and more

noticeably rounded. The large fenestra rotunda (pl. 6, fig. 3) is elliptical in outline and noticeably larger than the fenestra ovalis. The posterior face of the periotic is noticeably excavated above the fenestra rotunda, forming a broad dorsally directed groove. The foot plate of the stapes is lodged tightly in the ovoidal fenestra ovalis and is held in position by a pair of narrow internal ledges which extend across the anterior and posterior walls, respectively. Within the vestibule are the orifices of the three small canals, the two largest of which are situated opposite the epitympanic orifice of the aquaeductus Fallopii and lead to the semicircular canals; the other, a minute orifice, is situated at the posterointernal angle and is the terminus of the aquaeduct leading from the foramen singulare. On the internal wall there is a small passage which leads into the scala vestibuli. The epitympanic orifice of the aquaeductus Fallopii is small and opens into a narrow slit formed by the rim of the fenestra ovalis and the thin inwardly projecting ledge of the external portion of the periotic. The groove for the facial nerve, which leads from this aquaeduct, is sharply delimited externally and internally, and is markedly widened and deepened external to the fossa for the stapedial muscle and then extends backward along the dorsointernal face of the posterior process to and along the posterior face of the same process. A thin-edged rim separates the fenestra ovalis on the outside from the groove for the facial nerve and on the rear from the fossa for the stapedial muscle. The ovoidal fossa for the stapedial muscle is rather deep, concave from side to side, and extends downward on the external face of the pars cochlearis.

Along the internal margin of this fossa the thin-edged crest developed on the ventroexternal angle of the pars cochlearis extends backward to the posterior limit of the latter. The depth of the posterior face of this fossil periotic (9.8 mm.), as measured from the hindmost margin of the stapedial fossa to the fossa for the cerebral orifice of the aquaeductus vestibuli, is greater than the corresponding measurement of *Zarhachis flagellator*.

Between the irregular tuberosity or swelling on the basal portion of the anterior process and the anterior margin of the articular facet on the posterior process the ventral surface of the external denser portion of the periotic is narrowly depressed or excavated. The fossa incudis is reduced to a flattened oval area about 2 mm. in diameter and is located adjacent to the external rim of the groove leading from the aquaeductus Fallopii. This fossa incudis, which receives the crus breve of the incus, is shorter than that of *Zarhachis flagellator*, being prolonged farther posteriorly on the periotic of the latter.

The fossa for the reception of the head of the malleus is circular in outline, rather deeply concave, and is located on the internal face of

the irregular tuberosity on the basal portion of the anterior process. This fossa extends forward for the most part beyond the level of the epitympanic orifice of the aquaeductus Fallopii. The anterior process is elongated, obliquely truncated anteriorly, and directed obliquely inward. The main articular surface for the accessory ossicle or uncinate process of the tympanic bulla is an elongated concave depression which occupies the distal three-fourths of the ventral surface of the anterior process.

In its general features the confirmation of the cerebral face readily distinguishes this periotic (pl. 5, fig. 7) from those of other Calvert Miocene porpoises.

The internal acoustic meatus (pl. 6, fig. 2) is relatively small when contrasted with the orifice for the aquaeductus Fallopii through which passes the facial nerve. The channel for this aquaeduct is separated posteriorly by a low thin partition from the internal acoustic meatus. The minute orifice of the foramen singulare is located on the edge of this partition. The tractus spiralis foraminosus is well defined and terminates in the minute foramen centrale at the anterior end.

Outside the internal acoustic meatus and external to the unusually large cerebral orifice of the aquaeductus cochleae is the small orifice of the aquaeductus vestibuli which opens into a slit-like depression.

Measurements of the periotics (in millimeters)

	Right	Left
Breadth of periotic at level of fenestra ovalis (as measured from external face above groove to internal face of pars cochlearis)	20. 0	20. 0
Greatest length of periotic (tip of anterior process to tip of posterior process)	37. 5	40. 0
Greatest dorsoventral depth of periotic (as measured from most inflated portion of tympanic face of pars cochlearis and groove to most projecting point on cerebral face)		14. 2
Distance between fenestra rotunda and tip of anterior process	28. 0	28. 0
Distance between fenestra rotunda and anteroexternal angle of posterior process	16. 0	16. 4
Distance between epitympanic orifice of aquaeductus Fallopii and tip of anterior process		21. 0

Tympanic Bullae

Both of the tympanic bullae are unusually well preserved. The left tympanic bulla was detached from the periotic while the right one has been left in its normal relationship. These tympanic bullae are somewhat larger than those of either *Eurhinodelphis bossi* or *Rhabdosteus latiradix* and slightly smaller than those of *Zarhachis flagellator* (Kellogg, 1924, pl. 7, figs. 2, 4).

From a dorsal view (pl. 5, fig. 1) the inferior margin of the outer lip of the bulla is seen to be bent abruptly inward, forming a thin shelf to which the uncinate process is attached. The uncinate process which articulates with the elongate depression on the ventral face of the anterior process of the periotic is missing from the left bulla, but it is preserved in its normal position on the right bulla (pl. 6, fig. 1). This uncinate process is rather large, laterally compressed, and prolonged dorsally. The anterior end of the bulla is drawn out into a narrow projection which is directed forward and slightly downward, and constitutes the anterior outlet or tympanic aperture of the eustachian canal. The tympanic cavity is bounded by the overarching outer lip and by the involucrum. The thick involuted portion of the tympanic bulla is unevenly depressed below the level of the inwardly bent outer lip and rapidly diminishes in depth anterior to the middle of its length. The thick posterior portion of the involucrum is depressed dorsally and internally opposite the sigmoid process.

The posterior border and extremity of the sigmoid process are noticeably thickened; this process is twisted at a right angle to the long axis of the bulla. The posterior conical apophysis is somewhat flattened on its dorsal face, but otherwise the relations between the apophysis and the closely approximated sigmoid process are normal.

The elongated posterior process (pl. 5, fig. 3) is dorsoventrally compressed, emarginate distally, and is borne on a short slender neck; the articular facet for the posterior process of the periotic occupies less than half of the dorsal surface.

Measurements of tympanic bullae (in millimeters)

	Right	Left
Greatest length of bulla	50. 0	49. 5
Greatest depth of bulla on internal side (ventral face to dorsal face of involucrum)	18. 0	18. 5
Greatest depth of bulla on external side (ventral face to extremity of sigmoid process)	33. 0	34. 0
Greatest width of involucrum in epitympanic cavity		18. 0
Length of posterior process	21. 5	21. 0
Greatest width of bulla	30. 5	31. 5

The ventral surface of the tympanic bulla (pl. 5, fig. 2) is characterized by a rather broad and deep longitudinal groove, the depression becoming more pronounced anterior to the middle of its length. When viewed from the ventral side the outer contour of the bulla is biconvex and the inner contour exhibits a concave curvature. The bulla is much broader posteriorly than anteriorly.

When viewed from the external side (pl. 6, fig. 1), the posterior contour is seen to be convex, the ventral contour slightly convex posterior to the anterior projection, the posterior conical apophysis

partially concealed, and the sigmoid process directed more upward than backward.

Malleus

The malleus differs in several respects from that of *Kentriodon pernix* (Kellogg, 1927, figs. 8–13). The facets for articulation with the incus occupy more than one-third of the head of malleus and are located at the anterior end in a depressed area. The opposite facets meet medially at a right angle. The anterior end of the head is prolonged and forms a projecting conical point, and from it on the external side arises the minute tubercle or processus muscularis for insertion of the tensor tympani tendon.

The head of the malleus is borne on a slender stalk, the processus anterior (longus, gracilis, or folianus of authors), which becomes narrower as it approaches the outer lip of the tympanic bulla, fusing with the latter in the narrow groove between the sigmoid process and the uncinate process.

The longitudinal groove on the internal face of the tubercle at the anterior end of the head of the malleus may mark the area of attachment of the fleshy process (the "triangular ligament" of authors) of the membrana tympani. The malleus, including the anterior tubercle, measures 8.4 mm. in length and 4.3 mm. in width.

Incus

Two distinct facets comprise the surfaces by which the incus articulates with the corresponding facets on the malleus. The largest of these two facets is shallowly concave, subcrescentic in outline, and coextensive with the external face or base of the body of the incus; the smallest facet is deeply concave and is situated at the base on the ventral side. These two facets are separated from one another by a sharp ridge. From the body of the incus projects the crus longum, which is bent inward distally in a dorsointernal direction. On the dorsal end of the apical portion of the short conical crus breve is a small facet which rests in the fossa incudis. From the apex of the crus longum to the base of the body the incus measures 4 mm.; the greatest diameter of the base is 3.5 mm.

Stapes

The footplate of the slender stapes is closely fitted to the rim of the fenestra ovalis, although some slight side-to-side movement may have been possible. On the vestibular face of the footplate of the stapes is a distinct umbo or large oval concavity. The intercrural aperture is very minute and connects the concavities on the opposite sides of the stapes. A minute tubercle in the center of a small circular scar on the posterointernal angle of the head presumably marks the area for the

attachment of the stapedius muscle. The ovoidal concave facet on the slightly expanded distal end of the head constitutes the area of contact with the corresponding facet on the head of the crus longum of the incus.

Cervical Vertebrae

Four cervical vertebrae were associated with the mandibles. By a rather unusual modification, the ventroexternal angle of the broad transverse process of the third and fifth and presumably of the fourth cervical projects forward and outward. In this feature as well as the large size of the lateral arterial canals, these cervicals resemble the corresponding vertebrae of *Basilosaurus cetoides* and *Zygorhiza kochii* (Kellogg, 1936, fig. 10 and pl. 1) and differ in these respects from other known Calvert Miocene odontocetes. There is no indication, however, of any future tendency toward ankylosis of the individual cervical vertebrae. The sixth cervical has elongated and laterally compressed ventral transverse processes which are directed downward and outward. The third, fifth, and sixth cervicals have a rather broad longitudinal ridge on the ventral surface of the centrum.

Atlas: This vertebra (pl. 7, fig. 3) resembles the atlas of *Eurhinodelphis cocheteuxii* (Abel, 1931, pl. 19, fig. 2) in having robust upper transverse processes but differs in a number of other respects. The reduction of the lower transverse processes, the enlargement of the upper transverse processes, the elongation of the hypapophysial process, the height of the neural canal, and the anteroposterior diameter of the roof of the neural arch characterize this atlas.

The upper transverse processes are widened vertically, somewhat compressed in an anteroposterior direction, and project more outward than backward. The lower transverse processes are short and nodular. The facets for articulation with the occipital condyles are concave, widest near the middle of their height, and separated ventrally by an interval of 22 mm. The roof of the neural arch is not elevated medially—the anteroposterior diameter at center measuring 30 mm.—and is pierced on each side by a large vertebrarterial canal. The neural spine is low, broad, and blunt. The posterior facets for articulation with the axis are not identical in conformation. The left facet is somewhat elliptical and the right facet ovoidal in outline. Both facets are set off from the posterior face of the centrum externally, ventrally, and internally by projecting edges. The hypapophysial process is elongated, flattened dorsally, and somewhat rounded ventrally. Between the posterior facets and at the base of the rather broad neural canal is a narrow upwardly curving surface for articulation with the odontoid process of the axis which extends upward along the internal border of each lateral facet for at least half of the height of the latter.

Third cervical: This cervical vertebra (pl. 7, fig. 2) differs from the corresponding vertebra of both *Eurhinodelphis bossii* and *Rhabdosteus latiradix* by having much broader and shorter transverse processes, which have ventroexternal angles bent forward instead of backward, and by having large lateral arterial canals. The right prezygapophysial facet is ovoidal in outline and slopes steeply from external to internal margin. The right postzygapophysial facet is slightly convex, and slopes downward from external to internal margin. The neural canal is considerably wider (38 mm.) than high (18 mm.). The robust neural spine is short and is inclined backward. The anterior and posterior faces of the centrum are somewhat convex although depressed at the center. The median anteroposterior ridge on the ventral face of the centrum is rather broad (about 11 mm.) and separates deep lateral depressions. On both transverse processes the large arterial canal has a vertical diameter greater than the horizontal. Each transverse process is continuous dorsally with the pedicle of the neural arch; the dorsoexternal angle of each projects backward and the ventroexternal angle projects forward. Near the base of the anterior border of each transverse process a blunt tuberosity projects forward.

Fifth cervical: In many respects this cervical (pl. 7, fig. 4) is quite similar to the third cervical. Each transverse process is somewhat compressed anteroposteriorly, perforated at the base by a large rounded arterial canal, and connected dorsally with the lateral face of the pedicle of the neural arch by a thin plate. The dorsoexternal angle of each transverse process projects backward and the ventroexternal angle projects forward, resulting in the concave curvature of the anterior face distally. A small process similar to that of the third cervical projects forward near the base of the anterior border of the transverse process. The roof of the neural arch is narrow, although wider anteroposteriorly than that of the third cervical; the neural spine is short. The neural canal is wider (43 mm.) than high (34 mm.). The right prezygapophysial facet is subpyriform in outline, although flat, and slopes steeply from external to internal margin. The rather flat postzygapophysial facets are less elongated than the prezygapophysial facets and slope steeply downward from external to internal margins. The anterior and posterior facets project beyond the corresponding faces of the centrum. The anterior and posterior faces of the centrum are somewhat convex although depressed at the center. A broad median anteroposterior ridge on the ventral face of the centrum projects conspicuously below the lateral depressions.

Sixth cervical: Except for larger size and more robust build, this cervical (pl. 7, fig. 1) is quite similar in general conformation to the corresponding vertebra of *Rhabdosteus* and *Eurhinodelphis*. The transverse processes are directed downward, outward, and backward.

The broad ventral projection of each transverse process is flattened transversely; the upper portion is compressed anteroposteriorly, perforated at the base by a very large arterial canal and connected dorsally with the lateral face of the pedicle of the neural arch by a thin plate. The pedicles of the neural arch are stout and the neural canal is wider (47 mm.) than high (23 mm.). The anteroposterior diameter of the roof of the neural arch exceeds slightly that of the fifth cervical and the neural spine is low. The prezygapophysial facets are large and each slopes steeply from outer to inner margin. The left postzygapophysis is somewhat larger than the corresponding prezygapophysial facet and slopes much less steeply downward from external to internal margins. Both facets project beyond the corresponding faces of the centrum. The anterior face of the centrum is slightly convex but depressed at the center; the posterior face of the centrum is concave. The median anteroposterior ridge on the ventral face of the centrum is noticeably narrower than that of the fifth cervical and the lateral depressions are shallower.

MEASUREMENTS OF CERVICAL VERTEBRAE (IN MILLIMETERS)

	Atlas	C. 3	C. 5	C. 6
Greatest vertical diameter of articular surface for condyle (right)	55. 0			
Greatest transverse diameter of articular surface for condyle (right)	25. 5			
Least anteroposterior diameter of dorsal portion of neural arch	30. 0	13. 5	14. 5	17. 0
Least anteroposterior diameter of pedicle of neural arch		14. 5	14. 5	15. 5
Greatest height (vertically) of vertebra (tip of neural spine to ventral face of centrum)	91. 0	77. 5	86. 5	91. 5
Anteroposterior diameter of centrum	58. 0	31. 5	33. 5	39. 5
Distance across vertebra between tips of lower angles of transverse processes	94. 0	100. 0	108. 0	146. 0
Distance across vertebra between tips of upper angles of transverse processes (diapophyses)	108. 0	105. 0		130. 0
Distance between tip of prezygapophysis and tip of postzygapophysis		44. 0	50. 0	50. 0
Transverse diameter of neural (spinal) canal anteriorly	48. 0	38. 0	43. 0	47. 0
Maximum height of neural (spinal) canal anteriorly	46. 0	18. 0	34. 0	23. 0
Greatest distance across vertebra between outside margins of anterior articular facets	87. 0			
Greatest distance across vertebra between outside margins of posterior articular facets	87. 5			

Dorsal Vertebrae

The centra increase in length progressively from the first to the tenth in the dorsal series, and are broader than high. The width exceeds the length of the centrum of the first dorsal; the four posterior dorsals, seventh to tenth, have centra that are longer than wide. On each side of the centrum of the six anterior dorsals articular facets for the heads of the corresponding and succeeding ribs are situated at the upper anteroexternal and the upper posteroexternal angles; the upper anteroexternal facet alone is retained on the seventh dorsal. The pedicles of the neural arches are strong and occupy more than half the length of the centrum. On the five anterior dorsals the neck of the diapophysis is constricted dorsoventrally between the distal articular facet and the neural arch. The facets on the distal ends of the diapophyses for articulation with the tubercula of the ribs increase in width from the first to the sixth dorsals. On the second to fifth dorsals, inclusive, this facet projects forward beyond the level of the anterior face. On the eighth dorsal the diapophysis projects outward from near the base of the pedicle of the neural arch.

As will be noted from an examination of the illustrations, the backwardly projecting dorsal portion of the neural arch becomes progressively narrower toward the posterior end of the dorsal series. The anteroposterior diameter of the neural spine at the base increases from the anterior to the posterior end of the series. On the three anterior dorsals the anteroposterior diameter of the neural spine at the distal end is somewhat less than at the base, this difference being especially noticeable on the first dorsal. The neural spines of the two posterior dorsals have approximately the same anteroposterior diameter above the base. The prezygapophysial articular facets on the first dorsal are separated by a greater interval than on succeeding dorsals. Between the third and the ninth dorsals the width of the interval separating the prezygapophysial facets becomes markedly reduced. Each prezygapophysial facet is characterized by an upturned inner margin. The postzygapophysial facets of the six anterior dorsals project backward beyond the level of the posterior face of the centrum. The metapophyses of the ninth and tenth dorsals project forward beyond the level of the anterior face of the centrum.

First dorsal: On this vertebra (pl. 12, fig. 1) the diapophysis projects farther laterally than on the vertebrae that follow and the distal facet for articulation with the tuberculum of the first rib is situated behind the level of the anterior face of the centrum. A large facet for the capitulum of the first rib is located at the upper anteroexternal angle of the centrum (pl. 8, fig. 1) and a smaller facet for the capitulum of the second rib at the upper posteroexternal angle of the centrum.

The pedicles of the neural arch are strong and the neural canal is triangular in outline. As compared with the following vertebrae, the neural spine is relatively slender and slightly inclined forward. The prezygapophysial facets are large, deeply depressed posteriorly, and are separated by an interval of 41 mm. posteriorly. The postzygapophysial facets are large and slope obliquely from external to internal margins. The roof of the neural arch is narrow anteroposteriorly, the minimum diameter being 29 mm. The anterior and posterior faces of the centrum are shallowly depressed medially and the dorsal surface of the centrum is depressed on each side of the low median anteroposterior ridge. The centrum of this vertebra is the smallest of the dorsal series.

Second dorsal: The centrum of this vertebra (pl. 8, fig. 2) is longer than that of the first, the neural canal is smaller, and the minimum anteroposterior diameter (38 mm.) of the roof of the neural arch is greater. The neural spine is nearly vertical. The pedicles of the neural arch are low and robust. Each diapophysis projects upward, outward, and forward, and extends beyond the level of the anterior face of the centrum. The ovoidal lateral facet on the diapophysis for articulation with the tuberculum of the second rib is somewhat rugose, concave from end to end, and the anteroposterior diameter (28 mm.) is greater than the vertical diameter (21 mm.). The right prezygapophysial facet (pl. 12, fig. 2) is nearly flat, and slopes less steeply from external to internal margin than on the first dorsal; these facets are separated by an interval of 33 mm. posteriorly. The postzygapophysial facets are smaller than the anterior facets and somewhat rugose. The anterior and posterior faces of the centrum are depressed medially. The upper anteroexternal facet on the centrum for the capitulum of the second rib is smaller than the corresponding facet on the first dorsal, but slightly larger than the upper posteroexternal facet.

Third dorsal: Compared with the second dorsal, this vertebra (pl. 12. fig. 3) has shorter diapophyses, narrower neural canal, and broader neural spine. The backwardly projecting dorsal portion of the neural arch has a narrower transverse width than on the preceding dorsal. The prezygapophysial facets are large, concave, deeply depressed, and separated posteriorly by a relatively narrow interval (25± mm.). The right postzygapophysial facet is slightly convex, roughened, and slopes from external to internal margin. Each diapophysis projects outward, upward, and forward from the pedicle of the neural arch and projects forward beyond the level of the anterior face of the centrum; the ovoidal lateral facet for articulation with the

tuberculum of the third rib is rugose, deeply concave, and the anteroposterior diameter (21 mm.) exceeds slightly the vertical diameter (20 mm.). The lateral faces of the centrum (pl. 8, fig. 3) are depressed and curve concavely from anterior to posterior margins; the maximum width of the posterior face slightly exceeds that of the anterior face. The upper anteroexternal facet on the lateral surface of the centrum is elongated vertically and narrower anteroposteriorly than on the second dorsal; the upper posteroexternal facet is reduced in size.

Fourth dorsal: The length of the centrum is less than the width of the anterior face and the vertical diameter is about two-thirds the greatest width posteriorly; the anterior epiphysis is missing. This vertebra (pl. 12, fig. 4) is characterized by a rather low and wide neural canal; the backwardly projecting dorsal portion of the neural arch is noticeably contracted transversely posteriorly, as contrasted with the third dorsal. The neural spine is relatively narrow. The diapophyses project upward and outward and the concave rugose articular facet for the tuberculum of the fourth rib slopes obliquely downward and inward, the vertical diameter (21 mm.) being approximately equal to the anteroposterior diameter (22 mm.). The deeply depressed prezygapophysial facets are separated anteriorly by an interval of 17 mm. and project forward beyond the level of the anterior face of the centrum. The postzygapophysial facets have been broken off. The lateral (pl. 8, fig. 4) and ventral surfaces of the centrum are depressed and curve concavely from anterior to posterior margins. The upper anteroexternal and posteroexternal facets for articulation with the heads of the corresponding ribs are approximately the same size.

Fifth dorsal: In general appearance this vertebra (pl. 9, fig. 1) is quite similar to the fourth dorsal, with the exception of the more anterior position of the articular facet for the tuberculum of the fifth rib, the shorter pedicle of the neural arch, and the longer anteroposterior diameter of the neural spine. The robust diapophysis projects upward, outward, and forward at a lower level than on the fourth dorsal; the rugose subtriangular facet for the tuberculum of the fifth rib is concave, slopes downward and inward, and projects forward beyond the level of the anterior face of the centrum; the anteroposterior diameter (25 mm.) of the right facet exceeds slightly the vertical diameter (22 mm.). The concave prezygapophysial facets (pl. 12, fig. 5) are broad, and deeply depressed; the interval separating these facets can not be determined with certainty because of distortion resulting from crushing. The postzygapophysial facets are elongated, almost twice as long (23 mm.) as broad (12 mm.), and

slope obliquely from external to internal margins. The upper anterior and posterior facets for heads of the corresponding ribs are present on the lateral surface of the centrum. The transverse and vertical diameters of the posterior face of the centrum exceed the corresponding measurements of the anterior face; the ventral and lateral surfaces of the centrum curve concavely from anterior to posterior margins.

Sixth dorsal: Compared with the fifth dorsal, the backwardly projecting dorsal portion of the neural arch is narrower, the facet on the diapophysis for articulation with the tuberculum of the corresponding rib is smaller, the metapophyses project farther forward, the neural canal is reduced in width and height, and the pedicles of the neural arch are wider anteroposteriorly. The robust diapophysis (pl. 13, fig. 4) projects more outward than either upward or forward, and the concave distal facet for articulation with the tuberculum of the sixth rib is somewhat reniform in outline and is situated behind the level of the anterior face of the centrum. The concave prezygapophysial facets slope steeply from external to internal margins and are separated by an interval of less than 10 mm. Both postzygapophysial facets are eroded. The ventral and lateral faces of the centrum curve concavely from anterior to posterior margins, and the transverse width of the posterior face exceeds that of the anterior face. The anterior facet on the upper lateral surface of the centrum (pl. 9, fig. 2) for articulation with the capitulum of the sixth rib is larger than the corresponding posterior facet for the capitulum of the seventh rib.

Seventh dorsal: This vertebra (pl. 12, fig. 6) was badly damaged while the mandibles were being excavated. It lacks portions of both epiphyses, the pre- and postzygapophyses, the diapophyses, the dorsal portion of the neural arch, and the neural spine. Nevertheless, it should be noted that the height and width of the neural canal is less than on the preceding dorsal, the centrum is longer, and the diapophysis projects outward from the pedicle of the neural arch at a slightly lower level. The upper anteroexternal facet on the centrum (pl. 9, fig. 3) for articulation with the capitulum of the seventh rib is located on the anterior face of a protruding 3-sided tuberosity, foreshadowing the development of the rudimentary transverse process on the eighth dorsal. No posteroexternal facet for articulation with the eighth rib is developed on the centrum.

Eighth dorsal: On this vertebra (pl. 13, fig. 1) the neural spine, the backwardly projecting dorsal portion of the neural arch including the postzygapophyses, the right metapophysis and its prezygapophysial facet, and the left transverse process were destroyed during excavation. The elongated left prezygapophysial facet occupies

most of the internal surface of the metapophysis and slopes steeply downward from external to internal margins. The short dorsoventrally compressed left diapophysis projects outward from the pedicle of the neural arch. The distal facet on the diapophysis for articulation with the tuberculum of the eighth rib is elongated and is separated from the facet on the short transverse process for the capitulum of the same rib by an elongated groove measuring less than 10 mm. in vertical diameter. This dorsoventrally compressed transverse process (pl. 9, fig. 4) is situated at least 10 mm. behind the level of the anterior face of the centrum. The vertical and transverse diameters of the neural canal are less than on the preceding dorsal, the pedicles of the neural arch are noticeably reduced in height, and the left metapophysis projects forward beyond the level of the anterior face of the centrum.

Ninth dorsal: This vertebra (pl. 13, fig. 3) is characterized by short robust transverse processes (parapophyses), large markedly elevated and laterally compressed metapophyses, neural canal reduced and triangular in cross section, and broad neural spine. The centrum is longer than the preceding dorsal, and the width of the posterior face (62.8 mm.) exceeds the width (58 mm.) of the anterior face. Each parapophysis projects outward below the level of the dorsal face of the centrum and the distal facet for articulation with the single-headed ninth rib is deeply concave and rugose. The laterally compressed pedicles of the neural arch occupy more than half the length of the centrum; the vertical and transverse diameters (26 mm.) of the neural canal anteriorly are equivalent. The broad neural spine (pl. 10, fig. 1) is directed nearly vertically and is incomplete distally; the posterobasal portion of the spine is eroded in the region of the postzygapophyses. Narrow prezygapophysial facets separated by an interval of 10 mm. are present at the base and on the inside of each metapophysis.

Tenth dorsal: Longer transverse processes (parapophyses), longer centrum, and larger neural spine distinguish this dorsal (pl. 13, fig. 2) from the preceding vertebra. Each dorsoventrally compressed parapophysis projects outward from near the middle of the height of the lateral surface of the centrum and is narrowed slightly toward the distal end; the distal facet for articulation with the tenth rib is reduced in size. The laterally compressed pedicles of the neural arch resemble rather closely those of the ninth dorsal. No distinct prezygapophysial facets are retained at the base on the internal face of the large laterally compressed metapophyses. The large metapophyses (pl. 10, fig. 2) project anteriorly beyond the level of the anterior face of the centrum. The neural canal is triangular in cross section and similar in size to that on the preceding dorsal.

Measurements of dorsal vertebrae (in millimeters)

	D. 1	D. 2	D. 3	D. 4	D. 5	D. 6	D. 7	D. 8	D. 9	D. 10
Greatest vertical height of vertebra, ventral face of centrum to tip of neural spine	149.0			171.0					164.0+	178.0+
Vertical height of neural spine, dorsal surface of neural canal to tip of neural spine	70.5			100.0					93.5	102.5
Greatest anteroposterior diameter of centrum	44.0	51.0	51.2	52.5+	54.5	59.0	63.5	66.5	71.5	74.5
Greatest vertical diameter of anterior face of centrum	43.3	41.5	42.5	42.5	41.5	44.6	46.0	49.0	52.0	54.0
Greatest transverse diameter of anterior face of centrum	49.5	51.0	55.5	58.5	58.2	55.0		55.0	58.0	64.0
Greatest vertical diameter of posterior face of centrum	42.2	43.5	41.2	44.5	42.4	45.2	48.2	51.0	52.5	56.5
Greatest transverse diameter of posterior face of centrum	52.5	57.0	58.8	63.5	61.0	61.8	57.0+	57.5	62.8	64.5
Greatest vertical diameter of neural (spinal) canal anteriorly	44.5	40.0	38.8	28.0	34.0	24.0		24.0	26.0	26.0
Greatest transverse diameter of neural (spinal) canal anteriorly	44.5	40.0	31.0	36.0	27.0+	32.5		28.0	26.0	26.0
Least anteroposterior diameter of pedicle of neural arch	21.0	23.5	24.0	26.0	23.5	30.0	32.0	33.0	39.0	40.5
Distance across vertebra between outer ends of diapophyses	130.5	108.0	85.5	94.5	78.5	89.5		77.5		
Distance across vertebra between outer ends of parapophyses									118.8	
Anteroposterior diameter of diapophysis at extremity	24.5	28.8	27.5	34.5	33.5	26.5		22.5		
Anteroposterior diameter of parapophysis at extremity									37.5	
Greatest distance between outer margins of prezygapophysial facets	94.0	75.0	57.0	55.5	42.5+	44.0			28.0	
Greatest distance between outer margins of postzygapophysial facets	72.8	58.8			36.5	28.5				
Anteroposterior diameter of neural spine horizontally at base	31.5	36.5	44.0	48.0	52.5	49.0			59.0	67.0
Distance from inner surface of pedicle of neural arch to extremity of diapophysis	43.5	38.5	33.5	37.0	34.0	33.0		26.0		

Lumbar Vertebrae

Two lumbar vertebrae were associated with the dorsal vertebrae, one of which is partially destroyed and lacks not only the right side of the centrum but all processes as well. The anteroposterior diameter of the centrum is 86.5 mm., which, on the basis of the length (74.5 mm.) of the posteriormost dorsal, would indicate an anterior location in the lumbar series. The transverse diameter (64 mm.) of the centrum is approximately the same as the vertical diameter (63.5 mm.). The median longitudinal keel is best developed near the middle of the centrum. The remnant of the left transverse process indicates that it was broad at the base.

The other lumbar vertebra (pl. 10, fig. 3) is fairly well preserved but lacks the anterior portion of both metapophyses and the distal end of the neural spine. The centrum is longer (91 mm.) than the preceding and the lateral depressions on the ventral face are separated medially by the thin longitudinal ridge. No marked differences in the vertical and transverse diameters of the anterior and posterior faces of the centrum are observable.

The transverse processes (pl. 14, fig. 1) are elongated, broad at the base, and apparently truncated obliquely at the extremity. The height (17 mm.) of the neural canal anteriorly is less than the transverse diameter (21.5 mm.). On each side the pedicle of the neural arch occupies more than half the length of the centrum. The metapophyses were bent upward and directed outward and forward; they project anteriorly beyond tht level of the anterior face of the centrum. The neural spine is broad at the base with concavely curved anterior and posterior margins, but it should be noted that the posterobasal portion of the neural spine is eroded.

Caudal Vertebrae

The mingling of cervical, dorsal, lumbar, and caudal vertebrae in a horizontal space of less than three feet shows that the carcass either was in an advanced stage of decay or was torn apart before the bones were covered by sediments. It would appear that the bones were washed about by water action before they settled in a soft diatomaceous ooze. Four caudal vertebrae were found. Three are regarded as belonging to the anterior part of the caudal series and one is unquestionably from the terminal end. The caudal series of Recent odontocetes ranges from 18 in *Inia*, 18 in *Hyperodon*, and 19 in *Berardius* to 45 in *Lagenorhynchus*. In view of this variation it does not appear advisable to estimate the number of caudal vertebrae.

The largest of these four vertebrae probably represents the second or third in the caudal series. The distal end of the neural spine is missing and a portion of the left transverse process is destroyed.

Otherwise this caudal (pl. 11, fig. 1) is essentially complete. The pedicles of the neural arch occupy more than half the length of the centrum and the ovoidal neural canal diminishes in diameter from the anterior to the posterior end. The neural spine is broad at the base; the anterior and posterior edges of the neural spine are eroded. The metapophyses are strong, projecting upward and outward, and extend forward beyond the level of the anterior face of the centrum; their dorsal edges are at least 46 mm. above the level of the top of the centrum. The centrum is large, its transverse diameter posteriorly being greater than the corresponding measurement anteriorly, and its lateral surfaces deeply depressed between the pedicle of the neural arch and the transverse process. The posterior paired plate-like descending processes for the chevron are longer than the anterior pair; these processes contribute the lateral boundaries of the rather deep longitudinal groove on the ventral surface of the centrum. The dorsoventrally compressed transverse processes (pl. 13, fig. 5) were expanded anteroposteriorly distally, but truncated obliquely toward anterior and posterior distal angles.

The second largest caudal (pl. 11, fig. 2) of those excavated is slightly twisted from crushing, the neural spine is destroyed, the dorsal edges of the metapophyses are slightly worn, and a portion of the left transverse process is broken off. The length of the centrum is approximately the same as the more anterior caudal, but the transverse and vertical diameters of the anterior and posterior faces are reduced. The lateral face of the centrum between the pedicle of the neural arch and the transverse process is not only depressed but is divided by a longitudinal ridge. The posterior pair of plate-like descending processes on the ventral face for articulation with the chevrons are much longer than the anterior pair; these processes constitute the lateral boundaries of the longitudinal ventral groove which is somewhat deeper than on the anterior caudal. The pedicles of the neural arch are reduced in height and length; the neural canal is small, not more than 10 mm. in diameter. The metapophyses are robust, and project more outward than upward; they apparently projected forward barely beyond the level of the anterior face of the centrum. The transverse processes (pl. 14, fig. 2) are short and broad, and both are perforated at the base by an arterial canal. The transverse process on the right side is truncated obliquely distally from anterior to posterior angle.

The caudal (pl. 11, fig. 3) with a slightly shortened centrum was somewhat damaged during excavation and now lacks a portion of the posterior epiphysis and the adjoining region of the centrum, the hinder end of the neural arch, and major portions of the plate-like descending processes on the ventral face of the centrum. This caudal is characterized by a very short neural spine, a very small neural

canal (pl. 14, fig. 3), low neural arch, and short transverse processes perforated at the base by an arterial canal. The metapophyses project outward and do not extend forward to the level of the anterior face of the centrum. The longitudinal groove between the descending processes for articulation with the chevrons was wider and not depressed to the same extent as on the preceding caudal.

The caudal (pl. 15, fig. 1) from near the terminal end of this series is pierced dorsoventrally by two fairly large arterial canals, the dorsal orifices being separated by a wider interval than the ventral orifices. The anterior and posterior faces of the centrum are slightly concave.

Measurements of lumbar and caudal vertebrae (in millimeters)

	L	L	Ca	Ca	Ca	Ca
Greatest vertical height of vertebra, ventral face of centrum to tip of neural spine	209. 0+		155. 0+			
Ventral face centrum anteriorly to dorsal edge of metapophyses	111. 0		118. 0	105. 0	88. 0	
Vertical height of neural spine, dorsal surface of neural canal to tip of neural spine	128. 0+		66. 0+			
Greatest anteroposterior diameter of centrum	92. 0	88. 0	97. 5	97. 0	88. 0	42. 0
Greatest vertical diameter of anterior face of centrum	66. 0		70. 5	69. 0	71. 0	43. 0
Greatest transverse diameter of anterior face of centrum	70. 0		76. 0	73. 0	68. 0	54. 0
Greatest vertical diameter of posterior face of centrum	65. 0	64. 0	71. 8	67. 0		
Greatest transverse diameter of posterior face of centrum	69. 0	64. 0	78. 5	73. 8		
Greatest vertical diameter of neural canal anteriorly	18. 0		16. 5	12. 0	9. 0	
Greatest transverse diameter of neural canal anteriorly	22. 0		15. 0	10. 0	11. 0	
Least anteroposterior diameter of pedicle of neural arch	45. 0		53. 5	51. 0		
Distance across vertebra between outer ends of parapophyses	230. 0		164. 0	135. 0+	80. 5	
Anteroposterior diameter of parapophysis at extremity			56. 0			
Anteroposterior diameter of neural spine horizontally at base	68. 0		61. 0			
Distance from inner surface of pedicle of neural arch to extremity of parapophysis	130. 0		101. 0	86. 5		

Chevron Bones

Two chevron bones (pl. 15, figs. 2, 3) were found in the matrix surrounding the vertebrae. These chevrons have elongated, ovoidal, rugose surfaces for articulation with the corresponding facets of the caudals. The laterally compressed ventral blade is prolonged backward.

II. An apparently unrecognized odontocete in the Calvert Miocene of Maryland

Further studies of the Calvert Miocene odontocetes reveal a previously unrecognized porpoise. The materials on which this study are based were collected in 1914 and 1940, but were laid aside until some of the more perplexing problems involved in the determination of the identity of some of Cope's type specimens could be resolved, at least tentatively. In view of the presently available series of odontocete skeletal materials recovered during the past 40 years from the Calvert Miocene deposits of Maryland, it seems desirable to review briefly the status of our knowledge of the components of this marine fauna.

At least 13 genera of toothed whales were represented by one or more species in the Calvert Miocene fauna. The physeterid *Orycterocetus,* although of small size in comparison to the living sperm whale, was the largest of all the Calvert toothed whales. This small sperm whale possessed functional teeth in the upper jaws although they were lodged in an open continuous alveolar groove. Presumably 20 to 22 teeth were present in each upper jaw and 20 to 24 in each mandible. One skull, which may possibly represent an immature individual, measures approximately three feet in length. The adipose cushion or reservoir for spermaceti had spread backward behind the narial passages and, as a result of this enlargement, the relative proportions and relations of the bones forming the dorsal surface of the skull have been altered to conform to this large supracranial basin. The basin is bounded behind by the dorsal border of the supraoccipital and the right premaxillary (which overlies the frontal) and laterally by the elevated borders of the maxillaries. The vertex of the skull has been entirely eliminated, one of the nasal bones has either been lost or greatly reduced and the other flattened against the frontal behind the greatly enlarged left narial passage, and the rostrum has been expanded laterally at the proximal end. In contrast to skulls of other odontocetes, the roof of the braincase has been depressed below the normal position, seemingly as the result of the additional weight and presure of the developing spermaceti reservoir.

Shark-toothed whales of the family Squalodontidae were represented by the genus *Squalodon* (Kellogg, 1923). The skull of this porpoise measured at least three feet in length and the rostrum was nearly twice

as long as the braincase. In some respects the skull is less modified than those of other contemporary odontocetes since the mesethmoid divides the fontanelle between the frontals on the forewall of the braincase into two large foramina through which the olfactory nerves pass. Unlike other Calvert Miocene odontocetes, the dentition of *Squalodon* is heterodont and is regarded as consisting of 3 incisors, 1 canine, 4 or 5 premolars and 6 or 7 molars. There were 16 teeth present in each upper jaw and 14 in each mandible. The crowns of the cheek teeth (molars and premolars) have the anterior and posterior cutting edges serrated by well-defined accessory cusps. Comparative measurements indicate a skeletal length of 10 feet.

Another porpoise, *Phocageneus*, on the basis of available materials seems to be related to the lower Miocene Italian *Squalodelphis*, which has been regarded as either an offshoot of primitive Squalodontidae or a transitional form between the Squalodontidae and the Ziphiidae. The lower Miocene *Squalodelphis* has 15 teeth on each side in the upper and lower jaws that are regarded by Dal Piaz (1916, p. 23) as representing 3 incisors, 1 canine, and 11 premolars and molars. Unlike the genus *Squalodon*, the posterior teeth of both *Squalodelphis* and *Phocageneus* lack serrations on the anterior and posterior cutting edges. The enamel on the crowns of the teeth of *Phocageneus* and also those of *Squalodelphis* is coarsely corrugated or wrinkled, the crowns are somewhat compressed transversely on the distal half of their height, and a vertically directed carina is present on the anterior and posterior faces of at least the nine posterior mandibular teeth.

Most of the other types of Calvert porpoises possessed a somewhat homodont dentition and a considerably greater number of teeth than *Squalodon*. Of the four genera of unusually long-beaked porpoises, *Zarhachis* (Kellogg, 1924) was the largest. It appears to be an aberrant type with no known counterparts in the Miocene of either Europe or South America. The skull of *Zarhachis* was nearly 4 feet long and illustrates an extreme stage in the lengthening of the rostrum and the symphysis as well as reduplication of the teeth. As regards the number of teeth, 86 to 87 were located on each side of the rostrum and 70 to 72 in each mandible. A dorsoventral flattening of both the rostrum and the symphysis characterize *Zarhachis*. Furthermore, the terminal teeth on the symphysis occlude with the anteriormost pair of teeth on the rostrum. On the braincase the outer end of each supraorbital process of the frontal is bent upward to form a thickened longitudinal crest. Two crescentic orifices (Kellogg, 1926, pl. 2) enclosed by involuted ectethmoid bones for passage of olfactory nerves are present on the posterior wall of the nasal passages. The length of the skeleton of this long-beaked porpoise was approximately 16 feet.

Eurhinodelphis (Kellogg, 1925) also is characterized by an elongated rostrum which constitutes four-fifths of the total length of the skull. The distal one-third of the rostrum of the skull of old individuals is either edentulous or a cartilaginous ligament may have lodged small teeth in an uninterrupted narrow groove, which on each side extends from anteriormost alveola to extremity. The alveolae are closely spaced on the middle portion of the rostrum. The mandible is certainly abnormally shortened and does not extend forward to extremity of rostrum. Although some variation in the number of teeth may be anticipated, the type skull of *Eurhinodelphis bossi* has 59 teeth on the right side of the rostrum and 60 teeth on the left side. The full complement of teeth in the lower jaws may have approached the number lodged in alveolae in the upper jaws. Unfortunately the distal end of the symphysis of the above type specimen is missing, but in the present condition 50 teeth were present in the right mandible and 51 teeth in the left mandible. The alveolae are rather closely approximated on the mandibles. The length of this skull is 42 inches (1066 mm.), and the estimated length of the skeleton is 12 feet.

On the basis of recovered specimens *Rhabdosteus* (Cope, 1867) was far more numerous in the Calvert fauna than the other genera. The largest skull measures about 41 inches (1055 mm.) in length and the anterior one-third of the slender tapering rostrum projects at least 10 inches beyond the anterior extremity of the symphyseal portion of the mandibles. Four-fifths of the total length of the skull is constituted by the rostrum. Like *Eurhinodelphis*, the distal one-third of the rostrum on skulls of old individuals is seemingly edentulous, but on skulls of immature individuals the alveolae are distinct on this portion of the rostrum and closely spaced to or nearly to the extremity of the rostrum. On each side of the rostrum of a mature individual at least 39 teeth were present, and, although no alveolae persist on the anterior one-third of the rostrum, the presence of continuous alveolar grooves extending to the extremity suggest a condition similar to that described for *Eurhinodelphis*. Along the middle portion of the rostrum the alveolae are rather widely spaced and are separated by porous or spongy bone which fills the alveolar gutter between the roots of the teeth. Teeth are implanted the full length of the symphyseal portion of the mandibles. At least 36 teeth were present in each mandible. The teeth in the upper and lower jaws are characterized by a slender crown and a root markedly compressed from side to side and conspicuously widened toward the extremity as well as more or less prolonged at one basal angle. Comparative measurements suggest that the skeletal length of this porpoise may have been slightly shorter than that attributed to *Eurhinodelphis*.

Another long-beaked porpoise, *Schizodelphis* (True, 1908), occurs less frequently in Calvert Miocene. The dorsoventrally flattened rostrum and symphysis as well as the presence of a long longitudinal groove on the outer face of the symphyseal portion of each mandible and the flattened palatal surface of the rostrum readily distinguish this genus. Unlike either *Eurhinodelphis* or *Rhabdosteus*, the anterior end of the symphysis extends forward to the level of the anterior end of the rostrum. The estimated length of the type skull of *Schizodelphis crassangulum* is less than 30 inches (735 mm.). A count of the alveolae reveals 65 on each side of the rostrum and 67 in each mandible. The skeleton is not sufficiently well known from vertebrae to estimate the total length of this porpoise.

One occurrence has been reported for *Pelodelphis* (Kellogg, 1955, pp. 130–143, pls. 12–16), and, although thus far known only from the mandibles, this genus unquestionably possessed a skull with a shorter rostrum than either *Eurhinodelphis*, *Rhabdosteus*, or *Schizodelphis*, as well as fewer and somewhat larger teeth. Alveolae for 33 teeth are present on each mandible and when complete the full complement was probably 36 teeth. The skull undoubtedly was more lightly constructed than that of *Lophocetus*, but approximately the same length. The symphysis constituted slightly more than two-fifths of the length of either mandible.

The *Lophocetus* skull (Kellogg, 1955, pls. 1–3) is approximately 2 feet in length. It possessed 24 teeth on each side of the rostrum and 26 teeth in each mandible. The ankylosed symphysis constituted one-third the length of either mandible. The large and well worn teeth of the type specimen of *Lophocetus pappus* suggest a coarser type of food than that sought by porpoises with a markedly elongated rostrum. The skull is strongly constructed and is characterized by having the vertex of the braincase elevated, the posterior end of each premaxillary bent upward, forming an oblique crest adjacent to the longitudinally elongated nasal bone, and a rostrum equivalent to not more than three-fifths of the length of the skull.

Kentriodon (Kellogg, 1927) resembles in many respects the living *Sotalia* of South American fresh-water streams. The length of the skull varied from 12 to 13 inches and the rostrum comprised three-fifths of the total length of the skull. The symphysis did not quite equal one-third the length of either mandible. The teeth are small and closely spaced in the jaws; 40 teeth are present on each side of the rostrum and 38 in each mandible. A reconstruction of the skeleton indicates a total length of 5½ feet.

The rather broad braincase, the relatively short rostrum, and short symphysis of *Delphinodon* (True, 1912; Barwick, 1939) as well as the

peculiarities of the teeth readily distinguish this genus from other small Calvert porpoises. The type skull of *Delphinodon dividum* has 27 teeth on each side of the rostrum and 26 in each mandible, and the largest skull measures slightly more than 16 inches in length. The symphysis equals one-fifth the length of either mandible and the rostrum comprises 45 to 51 percent of the total length of the skull. The estimated length of this porpoise is about 6 feet.

Our present knowledge of *Tretosphys* (Kellogg, 1955, pp. 143–153, pls. 17–21) is limited to portions of the skull and mandibles, teeth, hyoid bones, an incomplete forelimb, and a few vertebrae. *Tretosphys gabbii* was a small porpoise whose ankylosed symphysis measured 147 mm. in length. There are 14 rather closely approximated alveolae located on each side of the symphysis. Anterior detached teeth have relatively smooth enamel on anteroposteriorly flattened crowns; teeth from near the middle of the tooth row have the enamel on the outer surface of the crown ornamented with fine striae; and the posterior teeth have either a fairly large accessory cusp with a denticulated cutting edge, or several small tubercles one above the other, or a rugose coarsely sculptured internal face of the crown.

In all probability the skull of the slender-beaked porpoise hereinafter described as *Araeodelphis* did not exceed 19 inches in length. More than 45 teeth were originally present on each side of the rostrum, and at least 46 and not more than 50 teeth were implanted in each mandible. Assuming that the number of caudal vertebrae of *Araeodelphis* did not exceed 20, the dimensions of the dorsal and lumbar vertebrae tentatively referred to this species suggest a skeletal length of 7 feet.

In the above review of the odontocete genera represented in the Calvert fauna, one notes that the reduplication of the teeth in the jaws has progressed at a variable rate. The full complement of teeth in each of these genera is summarized as follows:

Squalodon	60
Phocageneus	?60
Lophocetus	100
Delphinodon	106
Tretosphys	110±
Pelodelphis	144±
Rhabdosteus	150
Kentriodon	156
Araeodelphis	190+
Eurhinodelphis	210
Schizodelphis	264
Zarhachis	315

Araeodelphis,[1] new genus

Genotype: *Araeodelphis natator*, new species.

Diagnosis: Rostrum slender, attenuated toward anterior extremity; mesorostral trough roofed over by close approximation of premaxillaries; narrow median longitudinal groove on palatal surface extends forward from 45th tooth (counting backward from anteriormost alveola) to extremity; more than 45 teeth located on each side of rostrum.

Mandibles slender with symphysis firmly ankylosed, elongated, and tapered toward anterior extremity; width of symphysis greater than depth; median longitudinal groove on dorsal surface of symphysis indistinctly divided longitudinally for about two-thirds its length by the raised thin ridge formed at line of contact of mandibles; opposite free posterior portions of mandibles come together at a blunt angle (55°) at symphysis; external surface of each mandible convex dorsally above the deep channel or groove which commences about 20 mm. behind level of posterior end of symphysis and extends forward almost to anterior end; these channels or grooves on the opposite rami bound the median and somewhat convex longitudinal strip on ventral surface of symphysis; 36 to 37 teeth located on each side of symphysis.

Roots of teeth implanted in alveolae which slope more inward than backward; roots of teeth noticeably swollen below base of crown and attenuated near extremity; crowns of most of the teeth on symphysis and rostrum slender, pointed, and curved inward; enamel on crowns of majority of the teeth indistinctly wrinkled in a vertical direction on internal surface, but posterior teeth on symphysis have enamel more coarsely sculptured internally and possess a small tubercle on posterior margin of internal face; posterior teeth (41st to 45th) on rostrum possess one small tubercle on the posterior surface about half way of height of crown and a varying number of minute rugosities on internal surface; interval between teeth at base of crowns varies from 3 to 6 mm.

Araeodelphis natator, new species

Type specimen (USNM 10478): Essentially complete rostrum except for portion immediately in front of antorbital notches, symphyseal portion of mandibles, and 12 detached teeth. Collector, Norman H. Boss, July 1914.

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[1] From the Greek, "araios," thin, slender, and "delphis," dolphin, in allusion to slender rostrum and symphyseal region of mandibles.

Horizon and locality: Sandy clay of Calvert Cliffs, 1 mile south of Chesapeake Beach, Calvert County, Md. Calvert formation, upper Miocene.

Rostrum

This slender attenuated rostrum is characterized by a somewhat greater length than that of *Kentriodon pernix* (Kellogg, 1927, pls. 2, 6, 7), by closely approximated premaxillaries on the dorsal surface, by a narrow median longitudinal groove on the ventral surface which extends forward from the 45th tooth (counting backward from the anteriormost alveola) to the extremity, and by a greater number of teeth. The length of the rostrum of the largest known skull of *Kentriodon pernix* is 199 mm., while this rostrum, although incomplete, measures 337 mm.

At the hinder end of this rostral fragment (pl. 17, fig. 1) the maxillaries and the premaxillaries are approximately equal in width, but near the anterior extremity the width of the maxillary is greater than that of the premaxillary. Commencing at the level of the 38th tooth (counting backward from the anteriormost alveola) on the right side and continuing to the extremity of the rostrum, the inner borders of the premaxillaries are in contact, completely roofing over the mesorostral trough.

The conformation of the hinder end of the right premaxillary indicates that the premaxillaries are more or less flattened out and almost horizontal at the base of the rostrum, but anterior to the level of the 40th tooth (counting backward from the anteriormost alveola) these bones become rather strongly convex and slope from the inner to the outer margin, although they are less noticeably elevated above the maxillaries on the distal 80 mm. of the rostrum. Both premaxillaries decrease in breadth toward the extremity of the rostrum. Several nutrient foramina from which narrow grooves extend forward are located on the lateral surfaces of the premaxillaries. The premaxillaries and maxillaries are so firmly ankylosed that the line of contact is not clearly discernible on the anterior half of this incomplete rostrum. The slope of the maxillaries from the inner to the outer margin progressively diminishes toward the anterior extremity.

On the ventral side of the rostrum (pl. 16, fig. 2) the palatal surfaces of the maxillaries become progressively flattened in the direction of the antorbital notches and more noticeably convex anterior to the 35th tooth (counting backward from anteriormost alveola). The median longitudinal groove on the palatal surface diminishes in depth toward the anterior extremity. The ventral ridge of the vomer is visible on the palatal surface of the rostrum as far forward as the 35th tooth

(counting backward from the anteriormost alveola) and is thrust between the opposite maxillaries. More than 45 teeth were originally present on each side of the rostrum.

MEASUREMENTS OF ROSTRUM (IN MILLIMETERS)

Length of rostral fragment, as preserved	337. 0
Transverse diameter of rostrum at level of 39th alveola counting backward from anteriormost alveola of right maxillary	42. 0
Transverse diameter of rostrum at level of 5th alveola counting backward from anteriormost alveola of right maxillary	18. 5
Distance between alveolae of opposite tooth rows at level of 39th alveola counting backward from anteriormost alveola of right maxillary	30. 0
Distance between alveolae of opposite tooth rows at level of 30th alveola counting backward from anteriormost alveola of right maxillary	16. 0
Distance between alveolae of opposite tooth rows at level of 10th alveola counting backward from anteriormost alveola of right maxillary	10. 0
45 alveolae on right side of rostrum in an interval of	319. 0
38 alveolae on left side of rostrum in an interval of	277. 0

MANDIBLES

Both mandibular rami are broken off a short distance behind the posterior end of the symphysis. The symphysis is attenuated toward the anterior extremity, the transverse diameter diminishing from 50 mm. at the level of the posterior end to 11 mm. at the anterior end. The vertical diameter of the symphysis at the anterior end is slightly more than one-third the depth at the posterior end. The anterior extremity of the symphysis may lack only the anterior walls of the anteriormost alveolae.

The mandibles (pl. 16, fig. 3) are firmly ankylosed throughout the length of the symphysis; the line of ankylosis is indicated by the raised thin longitudinal ridge on the posterior 190 mm. of the median longitudinal groove on the dorsal surface of the symphysis. The dorsal surface of the symphysis is not flattened and is characterized chiefly by this rather deep median longitudinal groove measuring about 8 mm. in width at a point 40 mm. anterior to the posterior end of the symphysis and narrowing anteriorly to a width of about 1 mm. at a point about 40 mm. posterior to the anterior extremity. On each side of this median longitudinal groove and inside the tooth rows, the dorsal surface of each mandible comprising the symphysis is convex from side to side. On the ventral surface (pl. 17, fig. 2) the line of ankylosis is indicated by a continuous thin groove which extends medially the full length of the symphysis.

The blunt angle (55°) formed by the free hinder portions of the two mandibles of *Araeodelphis natator* where they meet to form the

symphysis is less acute than in *Acrodelphis letochae*. Brandt (1874, p. 22, pl. 3) states that the two mandibles of *Acrodelphis letochae* meet at a 25° angle. The two mandibles of *Champsodelphis lophogenius*, judging from the artist's illustration (Van Beneden and Gervais, 1880, pl. 57, fig. 10), meet at an angle of 35°. The transverse diameter of the symphysis of *Acrodelphis letochae* (Heiligenstadt, No. 15, Wien Mus.) is 20.5 mm., however, as contrasted to 50 mm. for the corresponding measurement of *Araeodelphis natator* and 43.2 mm. for *Champsodelphis lophogenius* (type, No. 11731, Lab. Paléont., Mus. Nat. Hist. Nat., Paris).

From a lateral view (pl. 16, fig. 1) the ventral profile is essentially straight. The external surface of the mandible is characterized by a deep channel or groove, commencing at a vascular foramen about 20 mm. behind the level of the posterior end of the symphysis and extending forward almost to the anterior end although diminishing in depth. No interruptions or breaks in the continuity of this groove are observable. This channel is about 6 mm. wide posteriorly and progressively narrows toward the anterior extremity of the symphysis. Short, anteriorly directed grooves from small vascular or nutrient foramina open into these channels. These longitudinal channels on the lateral surface of the right and left mandibles set off a somewhat convex ventral strip (pl. 17, fig. 2) which measures 15 mm. in width 30 mm. anterior to the posterior end of the symphysis and about 9 mm. in width 50 mm. behind the anterior end.

The mandible of *Acrodelphis letochae* (Abel, 1900, pl. 1, fig. 2), however, is characterized by a longitudinal groove on the lateral surface that originates in a vascular foramen approximately at the level of the posteriormost alveola and extends forward parallel to the alveolar edge at least as far as the posterior end of the symphysis. This longitudinal groove is then replaced at a slightly lower level by another deeper and more sharply defined longitudinal groove which continues forward in the same position to the anterior end of the symphysis as preserved. These grooves on the lateral surfaces of the ankylosed mandibles delimit the median longitudinal convex portion of the ventral surface of the symphysis. The interruptions or breaks in the continuity of these lateral grooves as well as the conformation of the median longitudinal portion of the ventral surface of the symphysis of *Acrodelphis letochae* are regarded as indicating that *Acrodelphis* and *Araeodelphis* are not closely related. Although some variability is expected in structures, such as vascular impressions, no collateral evidence is known which supports Abel's (1900, p. 849) contention that such grooves possess no generic significance. Grooves on mandibles of species of other odontocetes conform to the generic types, as, for instance, *Schizodelphis*.

Measurements of mandibles (in millimeters)

	Right	Left
Length of mandible, as preserved	359. 0	320. 0
Greatest length of ankylosed symphyseal portion of mandibles	291. 5	
Transverse diameter of ankylosed symphysis at posterior end	50. 0	
Vertical diameter of ankylosed symphysis at posterior end	24. 5	
Transverse diameter of ankylosed symphysis at anterior end	11. 0	
Vertical diameter of ankylosed symphysis at anterior end	9. 5	
Transverse diameter of ankylosed symphysis 100 mm. anterior to posterior end	26. 5	
Vertical diameter of ankylosed symphysis 100 mm. anterior to posterior end	16. 5	
Distance between alveolae of opposite tooth rows at level of posterior end of symphisis	36. 0	
Distance between alveolae of opposite tooth rows at the level of 35th tooth counting forward from posterior end of symphysis	6. 0	
Least distance between alveolae in tooth row	3. 0	
Maximum distance between alveolae in tooth row	5. 0	
37 alveolae in an interval of	296. 0	305. 0
35 alveolae on symphysis in an interval of	280. 0	288. 0
Anteroposterior diameter of largest alveola	5. 5	
10 teeth at hinder end of symphysis in an interval of	86. 0	88. 0
12 teeth at hinder end of symphysis in an interval of	102. 0	103. 0

Teeth

One tooth inserted near the anterior end of the symphysis of the mandible (seventh counting backward from anteriormost) by the preparator is in all probability misplaced since it possesses three small tubercles on the basal portion of the coarsely sculptured internal surface of the crown. With this exception, the crowns of the teeth (pl. 18, figs. 1–3) located in front of the posterior end of the symphysis are slender, relatively long, and curved inward, with vertically wrinkled or slightly fluted enamel on the internal surface and relatively smooth enamel on the external surface. The teeth have single roots. The roots are swollen or gibbous below base of the crown, abruptly curved backward at the extremity, and attenuated. Intervals between the basal portions of the crowns of the teeth are rather short, varying from 3 mm. anteriorly to 6 mm. posteriorly. Three teeth on the right side, two of which are situated anterior to the posterior end of the symphysis, have the internal surface of the crown coarsely sculptured or wrinkled and one small tubercle on the posterior margin about half way of height of crown.

Three detached teeth (pl. 18, figs. 4–6), apparently dislodged from the posterior free portion of the right mandible while the specimen was being prepared, have two slender pointed tubercles, one above the other on the posterior edge of the internal surface of the crown, as well as tongue-like projections on the enamel extending nearly

vertically from near the basal border of the internal surface. The anterior surface of the crown (pl. 18, fig. 4) of these teeth is characterized by irregular nodosities which contribute to the formation of a ledge about half way of its height. The enamel on the apical portion of the crown is relatively smooth. The crowns of these three teeth are shorter and more robust than the majority of the teeth on the mandible, although the apical portions are likewise curved inward. Immediately below the base of the crown, excrescences on the anterior and posterior surfaces abruptly widen anteroposteriorly the uppermost portions of the roots. On the symphysis, 37 teeth were present on the right side and 36 on the left side.

The crowns of the five posterior teeth on the right side of the rostrum are shorter, somewhat conical, and curved inward. The apices of the crowns are slightly worn. A varying number of minute rugosities are present on the internal surface of the crown and at least one small tubercle on the posterior surface is situated about half way of the height of the crown. The gibbous roots of the posterior teeth have a somewhat roughened surface immediately below the enamel crown. On the major portion of the rostrum the crowns of the teeth (pl. 16, fig. 1) are slender, relatively long, and curved inward, with vertically wrinkled enamel on the internal surface and relatively smooth enamel on the external surface. These teeth have gibbous roots (pl. 18, figs. 1–3).

As regards some of the Calvert Miocene porpoises it should be noted that the number of teeth located on the free portion of each ramus behind the posterior end of the symphysis varies considerably, ranging from 11 to 12 in *Pelodelphis*, 14 to 15 in *Delphinodon*, and 18 to 19 in *Kentriodon*. Other fossil porpoises known from the Helvetian deposits of the Department of Landes, France, as, for instance, *Champsodelphis lophogenius* (Valenciennes, 1862) and *C. dationum* (referred mandible, Van Beneden and Gervais, 1880, p. 488, pl. 57, fig. 11) have 10 to 11 teeth on the free portion of each mandible. In view of the length of the symphysis one might anticipate that the minimum number of teeth in each mandible of *Araeodelphis natator* would be 46 and the maximum 49 or 50.

All of the teeth on the type mandible of *Champsodelphis lophogenius* have rather smooth enamel on the outer surface of the crown. The shelf on the inner side at the base of the crown does not resemble a cingulum, but nevertheless it is quite prominent; the enamel on this basal region of some of these teeth is characterized by faint striae and minor vertical grooves. Valenciennes (1862, pp. 788–789) refers to an excessively small vestige of a tubercle at the base of the crown, although I failed to observe it at the time the type specimen was examined. The apices of the teeth are pointed and curved inward

and backward. The neck of the root is slightly constricted below the enlargement of the base of the crown. The measurements of these teeth are as follows: height of enamel crown, 5.9 to 7.4 mm.; anteroposterior diameter of crown at base, 4.9 to 5.5 mm.; transverse diameter of crown at base, 5.4 to 5.8 mm. On the left mandible 10 alveolae occupy an interval of 114 mm. These teeth of *Champsodelphis lophogenius* are, however, more robust than those of *Araeodelphis natator*, the base of the crown being more noticeably enlarged, and the root slightly constructed immediately below the base of the crown. The roots of the teeth of *Araeodelphis natator*, however, are conspicuously swollen below the base of the crown and the measurements are as follows: height of enamel crown, 6 to 8.2 mm.; anteroposterior diameter of base of crown, 2.9 to 3.0 mm.; and transverse diameter of base of crown, 2.7 to 3.8 mm.

The teeth of *Acrodelphis letochae* (Pia, 1937, p. 363) that are located in the free portion of the mandible behind the posterior end of the symphysis have crowns that are curved distally, are approximately circular in cross section, and lack any trace of tubercles, granulations (rugosities), or edges. Pia (1937, p. 363) has also commented that the teeth of *Acrodelphis letochae* do not agree with those of "*Champsodelphis*" *ombonii* (Longhi, 1898) and that these two species are not generically related as Abel (1905, pp. 130–132) assumed. The type mandible of *Acrodelphis letochae* has 14 teeth in an interval of 64 mm. There are 14 teeth on the posterior portion of the symphysis of *Araeodelphis natator* in an interval of 123 mm.

The teeth on the mandible referred to *Champsodelphis dationum* by Gervais (Van Beneden and Gervais, 1880, p. 488, pl. 57, fig. 11) approximate more closely in dimensions the teeth of *Araeodelphis natator*. The teeth are described by Gervais (1859, p. 306) as having pointed crowns that curve inward and that have smooth enamel, a constricted neck, and a slightly swollen root. The measurements of the largest of these small teeth are as follows: height of enamel crown, 6 mm.; greatest width of crown, nearly 3 mm. Twelve alveolae occupy an interval of 110 mm. on the left mandible; height of mandible at last tooth, 35 mm.; and height of posterior end of symphysis, 28 mm.

Measurements of the teeth (in millimeters)

	Anteromedian (pl. 18, fig. 1)	Median (pl. 18, fig. 2)	Median (pl. 18, fig. 3)	Median	Posterior (pl. 18, fig. 4)	Posterior (pl. 18, fig. 6)	Posterior (pl. 18, fig. 5)
Greatest length, as preserved	19.7	16.5	16.4	17.0+	15.5	14.4	15.2
Length of root	12.5	8.7	8.5	8.3+	9.6	8.5	9.4
Greatest diameter of root	5.0	5.5	4.4	5.0	5.3	5.7	5.3
Height of crown	7.0	8.2	7.5	8.0	6.0	6.4	6.0
Greatest anteroposterior diameter of crown	3.0	3.0	3.0	3.0	3.0	3.0	2.9
Greatest transverse diameter of crown	2.7	2.8	2.8	3.0	2.9	3.5	3.8

Referred Specimen

USNM 16569: Six cervical (not including atlas), 10 dorsal and 5 lumbar vertebrae; eleven ribs. Collectors, William F. Foshag and Remington Kellogg, Aug. 6, 1940.

Horizon and locality: Compact, sandy, blue clay of Zone 11, about 5 feet above base of cliff, approximately 1.2 miles north of mouth of Parker Creek, William Freeland farm, Calvert County, Md., Calvert formation, upper Miocene.

A consecutive series of vertebrae extending from the axis to and including the fourth lumbar were found embedded in their normal sequence when the specimen was excavated. Following extended comparisons with the vertebrae of other small Calvert odontocetes, and the resultant elimination from further consideration of all forms heretofore recognizable in this fauna, it seemed reasonable to assume at least tentatively that this vertebral series represents *Araeodelphis natator.*

Vertebrae

With the exception of the atlas, all of the vertebrae in the cervical series are preserved. Ten consecutive vertebrae represent the dorsal series. The five lumbar vertebrae belong to the anterior portion of this series.

Cervical Vertebrae

All of the cervical vertebrae were free, the series consisting, when complete, of seven vertebrae. The diagnostic features of this series may be summarized as follows: Axis characterized by a slender and elongated neural spine, short and blunt odontoid process and maximum transverse diameter approximately equal to height; neural spines of third to sixth cervicals short; ventral transverse processes of third to fifth cervicals directed obliquely backward and perforated at the base by an arteri al canal, which increases in size from third to sixth cervical; ventral transverse processes of sixth cervical relatively large and directed downward, outward, and backward; seventh cervical lacks ventral transverse processes and the dorsal transverse processes are blade-like and attenuated distally; pre- and postzygapophyses similar in position and inclination on the third to seventh cervicals, although those of the seventh are somewhat larger than on the preceding vertebrae; axis and third to seventh cervicals exhibit a longitudinal carina on the ventral face of the centrum; there is a slight progressive increase in the thickness of the centra of the third to seventh cervicals.

Axis: In comparison to the axis of *Delphinodon dividum* (True, 1912, pp. 176, 182, pl. 19, figs. 5, 6) this vertebra (pl. 19, fig. 1) is somewhat larger, measuring 89 mm. in height, and its greatest thickness antero-

posteriorly (29.5 mm.) is slightly less than one-half its breadth anteriorly (63 mm.). The neural spine is slender, elongated, and inclined backward; the posterior face of the spine is rugose and a sharp vertically directed carina is developed on the anterior face. This spine differs from that of *D. dividum* in being noticeably elongated and not expanded distally. The ventral transverse processes were relatively slender, elongated, and directed obliquely backward. The height of the neural canal anteriorly is approximately equal to the transverse diameter. The anterior facets (pl. 20, fig. 1) for articulation with the atlas are shallowly concave from side to side—the vertical diameter (27 mm.) of right facet being greater than the maximum transverse diameter (20.5 mm.)—and they are separated ventrally by an interval that barely exceeds the vertical diameter of the right facet. The odontoid process is short, blunt, and somewhat rugose dorsally, and its rather large ventral articular face (transverse diameter, 20.5 mm.; anteroposterior diameter, 20 mm.) is convex in both directions. On the right side the postzygapophysial facet is ovoidal in outline and slopes obliquely downward from external to internal margins. The posterior face of the centrum is deeply concave and considerably wider (40 mm.) than high (26.5 mm.). On each side of the median longitudinal ridge the ventral surface of the centrum is deeply depressed. The dorsal surface of the centrum is also depressed on each side of the median longitudinal ridge.

Third cervical: This vertebra (pl. 19, fig. 2) is characterized by a thin centrum, slender pedicles of the neural arch, a very short neural spine, and slender transverse processes. The right prezygapophysial facet is not only shallowly concave but is depressed posteriorly. Relatively flat and ovoidal postzygapophysial facets slope steeply from the external to the internal margins. The neural canal is considerably wider (21.5 mm.) than high (16 mm.). The centrum has a slightly convex anterior face, a concave posterior face, and a median anteroposterior ridge on the dorsal and ventral faces which separates depressions on each side. On the right transverse process (pl. 20, fig. 2), the arterial canal which perforates the base of this process is large, but on the left transverse process a thin transverse isthmus of bone divides this canal anteriorly. In contrast to *D. dividum* (True, 1912, pl. 19, figs. 7, 8), each slender, elongated, and backwardly curved transverse process projects from the lateral surface of the centrum but is not continuous dorsally with the pedicle of the neural arch.

Fourth cervical: The centrum (pl. 19, fig. 3) is thin, although slightly thicker than the third cervical, the pedicles of the neural arch are wider transversely, and the neural canal is narrower. The roof of the neural arch is narrow anteroposteriorly; the neural spine is very short and obliquely truncated distally. Each transverse process

(pl. 20, fig. 3), although slightly shorter than the process on the third cervical, is attenuated distally, curved outward and backward, and perforated at the base by an arterial canal. The centrum is depressed medially on the anterior face, the posterior face is concave, and the median anteroposterior ridge on the dorsal and ventral faces separates the depressed areas on each side. Shallowly concave and ovoidal prezygapophysial facets slope steeply from external to internal margins. The elongated postzygapophysial facets are twice as long as wide and slope obliquely from external to internal margins. The pre- and postzygapophyses respectively project noticeably beyond the level of the anterior and posterior faces of the centrum.

Fifth cervical: This cervical has a smaller neural canal, the pedicles of the neural arch are narrower transversely, and the centrum is relatively larger than the corresponding vertebra of *D. dividum* (True, 1912, pl. 19, figs. 11, 12). The roof of the neural arch is rather narrow anteroposteriorly and the neural spine is reduced to a low sharp ridge. Each transverse process (pl. 20, fig. 4) is compressed anteroposteriorly, truncated obliquely distally, perforated at the base by a very large arterial canal, and connected dorsally with the lateral face of the pedicle of the neural arch by a thin anteriorly curved plate which is an extension of the lateral face of the centrum.

The anterior face of the centrum is depressed in the center and the posterior face is concave; the median anteroposterior ridge on the depressed dorsal face is reduced; and four depressions separated by low anteroposterior ridges alter the conformation of the ventral face. The prezygapophysial facets are unusually large, shallowly concave, and slope steeply downward from external to internal margins. The postzygapophysial facets are subtriangular in outline, rather flat, and slope obliquely from external to internal margins. All of these facets (pl. 19, fig. 4) project beyond the corresponding faces of the centrum.

Sixth cervical; In contrast to the preceding cervical, the ventral transverse processes (pl. 19, fig. 5) are directed more downward than outward, the large arterial canals extend farther dorsally, and the neural canal is slightly wider. The roof of the neural arch is narrow anteroposteriorly; the neural spine is short and pointed.

The ventral transverse processes (pl. 20, fig. 5) are robust and are directed downward, outward, and backward. On the right side, the outer wall of the arterial canal is thin and compressed anteroposteriorly and is continuous dorsally with the anterior border of the pedicle of the neural arch. The pedicles of the neural arch are compressed from side to side and widened anteroposteriorly. The anterior and posterior faces of the centrum are concave; the median anteroposterior ridge which divides the depressed dorsal face is low in comparison to

the development of the same ridge on the depressed ventral face. The prezygapophysial facets are elongated, almost twice as long (14 mm.) as broad (7.5 mm.), shallowly concave, and slope very steeply from the external to internal margins. The postzygapophysial facets are likewise elongated, but are attenuated anteriorly. This cervical is readily distinguished from the corresponding vertebra of *D. dividum* (True, 1912, pl. 19, fig. 13) by the shape and direction of the transverse processes, by the relatively smaller size of the neural canal, and by the dimensions of the arterial canal.

Seventh cervical: As regards thickness, the centra of the sixth and seventh cervicals are about equal. The anterior and posterior faces of the centrum are shallowly concave; the dorsal face of the centrum is depressed; and the ventral face has two elongate depressions on each side of the median anteroposterior ridge. A vertically elongated posterior facet (pl. 19, fig. 6) for the capitulum of first rib is located on the lateral face of centrum; the blade-like dorsal transverse processes are attenuated toward the extremity, each being broadly united at the base with the pedicle of the neural arch and directed outward. No trace persists of the ventral transverse processes. The neural canal (pl. 20, fig. 6) is much wider (24 mm.) than high (15 $\pm$ mm.) and the roof of the neural arch has increased slightly in anteroposterior diameter. The pedicles of the neural arch resemble those of the sixth cervical, but have a greater anteroposterior diameter. The prezygapophysial facets are elongated, shallowly concave, and slope steeply from external to internal margins. The ovoidal postzygapophysial facets are somewhat longer (13 mm.) than wide (10 mm.) and likewise slope obliquely from external to internal margins.

Dorsal Vertebrae

With the exception of the distal portions of the neural spines of the fifth, seventh, eighth, and ninth dorsals and the right diapophyses of the second and third dorsals, all of these vertebrae are well preserved and little or no distortion from crushing is evident.

The centra progressively increase in length from the anterior to the posterior end of the dorsal series, the centrum of the posterior dorsal being almost three times as long as the first. The shape and size of the neural spine, the width of the interval between the prezygapophysial facets, and the peculiarities of the diapophyses characterize each of the dorsal vertebrae. On these vertebrae as well as those of related fossil porpoises of the Calvert Miocene, a progressive decrease in the width of the interval separating the prezygapophysial facets from the anterior to the posterior dorsal is a normal feature. These facets become increasingly oblique in position toward the posterior end of the dorsal series. On the first four dorsals the facet on the dia-

pophysis for articulation with the tuberculum of the rib is situated in front of the level of the anterior face of the centrum, but on the sixth it is entirely behind the level of the anterior face.

On the six anterior vertebrae in the dorsal series, the vertical diameter of the facet on the diapophysis for articulation with the tuberculum of the rib is greater than the anteroposterior diameter in contrast to the pronounced anteroposterior elongation of these facets on the corresponding vertebrae of *Delphinodon dividum* (True, 1912, pl. 20, figs. 1–9); furthermore, the prezygapophysial facets slope steeply from external to internal margins while those of *D. dividum* are nearly horizontal.

The transverse processes of the transitional vertebra are not perforated by an arterial canal near the base. The slender neural spines of the five anterior dorsals progressively increase in height. Behind these vertebrae the neural spines become wider on the basal half.

A well defined facet for articulation with the capitulum of the rib is located at the upper posteroexternal angle of the centrum of the first to seventh dorsals. On the first dorsal, the diapophyses project farther laterally than on the vertebrae that follow. The relative height of the diapophysial articular facet above the centrum does not change materially on the eight anterior dorsals. On the ninth dorsal the shift to a lower level is rather pronounced since each process projects from the side of the neural arch about midway between centrum and the top of the neural canal. The postzygapophysial facets become progressively reduced (shorter) toward the posterior end of the dorsal series and are barely discernible on the tenth dorsal.

First dorsal: The anterior dorsal (pl. 21, fig. 1) is characterized by a shorter centrum than those that follow in this series—the transverse diameter being more than a third greater than the maximum anteroposterior diameter—by a vertically elongated anterior facet for the capitulum of the first rib on the lateral face, and by a small facet for the capitulum of the second rib at the upper posteroexternal angle of the centrum. The neural spine is relatively slender, rather short, and slightly inclined forward. The neural arch (pl. 22, fig. 1) is low, robust, and with a laterally projecting diapophysis on each side which bears a dorsoventrally prolonged concave articular facet for the tuberculum of the first rib. This facet slopes downward and inward. The postzygapophysial facets are elongated, the anteroposterior diameter (18 mm.) being twice the maximum transverse diameter (9 mm.), and slope obliquely from external to internal margins. The ovoidal prezygapophysial facets are 17 mm. in length and 9.5 mm. in breadth and slope steeply from external to internal margin. The width (22.5 mm.) of the neural canal anteriorly exceeds slightly the vertical diameter (18 mm.), and the prezygapophysial facets are separated by

an interval of 31 mm. posteriorly. The roof of the neural arch is rather narrow anteroposteriorly, the minimum diameter being 12 mm. The centrum has concave anterior and posterior faces, and a low median anteroposterior ridge on the dorsal and ventral faces that separates the depressed areas on each side. A small arterial foramen is located on each side of this ridge on the dorsal face.

Second dorsal: Compared with the first dorsal, the centrum is longer, the neural spine is higher, the neural canal is larger, and the minimum anteroposterior diameter (18 mm.) of the roof of the neural arch is greater. The slender neural spine (pl. 21, fig. 2) is nearly vertical and is obliquely truncated at the extremity. The diapophysis projects upward, forward, and outward. The subpyriform lateral facet on the diapophysis for articulation with the tuberculum of the second rib is concave from side to side, the vertical diameter (19.5 mm.) being greater than the transverse diameter (14.5 mm.).

The left ovoidal prezygapophysial facet measures 14.5 mm. in length and 11 mm. in breadth and slopes steeply from external to internal margin. The left postzygapophysial facet is nearly subquadrate in outline, measuring 12.5 mm. in length and 11 mm. in width, and slopes obliquely from external to internal margins. Anteriorly, the neural canal (pl. 22, fig. 2) is slightly wider (23 mm.) than high (22 mm.). The anterior and posterior faces of the centrum are slightly concave at the center, two arterial foramina of moderate size are present on the depressed dorsal face, and the lateral faces are deeply depressed. The upper posteroexternal facet for the capitulum of the third rib is larger than on the preceding dorsal.

Third dorsal: This vertebra (pl. 21, fig. 3) differs from the corresponding vertebra of *Delphinodon dividum* (True, 1912, pl. 20, fig. 2; pl. 22, fig. 2) in having the diapophyses projecting obliquely upward and outward, the long axis of the articular facet for the tuberculum of the third rib nearly vertical, and prezygapophysial facets steeply sloping. The backwardly projecting dorsal portion of the neural arch has a greater transverse width (38.5 mm.) than on either the preceding or following dorsal. The neural spine has increased in width anteroposteriorly. The maximum width (25 mm.) of the neural canal (pl. 22, fig. 3) anteriorly is slightly greater than the height (23.5 mm.). The left prezygapophysial facet is irregularly depressed, is 17 mm. in length and 13 mm. in breadth, and slopes obliquely downward from external to internal margin. The postzygapophysial facets are ovoidal and likewise slope obliquely. A pair of arterial foramina much larger than those on the second dorsal are present on the depressed dorsal face. The lateral faces of the centrum are depressed and curve concavely from anterior to posterior margins, and the maximum width (37 mm.) of the posterior face exceeds that of the anterior

face (30.7 mm.). A large triangular facet for the capitulum of the fourth rib is located obliquely on the centrum at the upper posteroexternal angle.

Fourth dorsal: The length (30.5 mm.) of the centrum barely exceeds the width (30 mm.) of the anterior face, although the posterior face is somewhat wider (37 mm.). This vertebra (pl. 21, fig. 4) is characterized in part by a high slender neural spine which curves backward toward the extremity. The diapophyses project upward and outward, and the subtriangular articular facet for the tuberculum of the fourth rib slopes obliquely downward and inward, the vertical diameter (17.5 mm.) of the facet being greater than the anteroposterior diameter (15.5 mm.). The steeply sloping prezygapophysial facets are longer (17.5 mm.) than wide (13.5 mm.), concave from side to side, and irregularly depressed. The postzygapophysial facets are elongated and likewise slope obliquely from external to internal margins. The anteroposterior diameter of the backwardly projecting dorsal portion of the neural arch exceeds that of the third dorsal. A pair of large arterial foramina are present on the depressed dorsal face; the lateral and ventral faces of the centrum are depressed and curve concavely from the anterior to posterior margins. The maximum width (25 mm.) of the neural canal (pl. 22, fig. 4) anteriorly is equivalent to the height (25 mm.). The large triangular facet for the capitulum of the fifth rib is located obliquely on the centrum at the upper posteroexternal angle.

Fifth dorsal: In general appearance this vertebra (pl. 21, fig. 5) resembles the fourth, with the exception of the more posterior position of the articular facet for the tuberculum of the rib and an obvious narrowing and elongation of the backwardly projecting dorsal portion of the neural arch. A slight reduction in size of the neural canal (pl. 24, fig. 1), the width and the height being approximately equal, and a narrowing of the minimum interval (16.5 mm.) between the prezygapophysial facets also characterize this dorsal. The centrum is slightly longer than that of the fourth and is more noticeably constricted from side to side between the anterior and posterior faces. The pair of arterial foramina on the dorsal surface of the centrum are as large as those of the fourth dorsal. The neural spine, although lacking the distal end, is similar in conformation and backward inclination to the spine of the fourth dorsal. The diapophyses project upward and outward and the subtriangular articular facet for the tuberculum of the fifth rib slopes less obliquely downward and inward and is placed almost entirely behind the level of the anterior face of the centrum; the anteroposterior diameter (14 mm.) of the left facet is slightly less than the vertical diameter (15.5 mm.). The prezygapophysial facets are concave, longer than wide, and slope obliquely

from external to internal margins. The obliquely sloping elongated postzygapophysial facets are almost twice as long (16.5 mm.) as broad (9 mm.). The large triangular facet for the capitulum of the sixth rib is located obliquely on the centrum at the upper posteroexternal angle.

Sixth dorsal: When the postzygapophysial facets of the fifth dorsal are placed in articular position with the prezygapophysial facets of this vertebra, it will be observed that these paired facets articulate rather loosely in contrast to the more restricted articular relations of the preceding dorsals. The ovoidal prezygapophysial facets are elongated, deeply concave, slope steeply from external to internal margins, the length (18.5 mm.) of the left facet exceeds the maximum transverse diameter (11 mm.), and the minimum interval between these facets posteriorly is reduced to 14 mm. The obliquely sloping postzygapophysial facets measure 13.5 mm. in length and 7 mm. in breadth. Compared with the fifth dorsal the backwardly projecting dorsal portion of the neural arch is noticeably narrower and the anteroposterior diameter (35 mm.) of the neural spine at the base is also greater than the corresponding measurement (30 mm.) of the spine of the preceding vertebra. The diapophyses of this vertebra (pl. 23, fig. 1) are more robust than those of the fifth dorsal and project less noticeably upward; the diapophysial articular facet is slightly smaller, but likewise is located behind the level of the anterior face of the centrum. The height (24 mm.) of the neural canal (pl. 24, fig. 2) anteriorly is equal to the width. The centrum is longer than that of the fifth dorsal, the maximum width (37 mm.) of the posterior face is greater than the anterior width (30.2 mm.), and the strong lateral constriction has reduced the ventral surface to an indistinct ridge. A pair of arterial foramina are present on the dorsal face. The large triangular facet for the capitulum of the seventh rib is located obliquely on the centrum at the upper posteroexternal angle.

Seventh dorsal: This vertebra (pl. 23, fig. 2) differs from the preceding vertebra in having the articular facet on the diapophysis elongated anteroposteriorly, a noticeably narrower backwardly projecting portion of the neural arch, no pronounced widening of the posterior face of the centrum as contrasted with the anterior face, and the absence of an articular facet for the capitulum of the eighth rib at the upper posteroexternal angle of the centrum. The more nearly circular but deeply concave prezygapophysial facets slope steeply from external to internal margins, and the minimum interval between these facets posteriorly does not exceed 10 mm. Each postzygapophysial facet is reduced to an irregular depression located on the external face of the basal portion of the neural spine. Although the major upper portion of the neural spine is broken off, the inclina-

tion of the posterior edge suggests that it was similar in conformation to that of the eighth dorsal; the anteroposterior diameter (35 mm.) of the neural spine at the base is approximately the same as on the sixth dorsal.

The diapophyses project outward but not upward and are located entirely behind the level of the anterior face of the centrum. The height (23 mm.) of the neural canal (pl. 24, fig. 3) anteriorly is slightly less than the transverse diameter (24 mm.). The pedicles of the neural arch are widened anteroposteriorly but lack the lateral depression of the preceding dorsals. The centrum is longer than that of the sixth and the width (32.5 mm.) of the posterior face exceeds very slightly the width (31.8 mm.) of the anterior face; the pronounced lateral constriction of the centrum has reduced the ventral face to a low ridge. The pair of arterial foramina on the dorsal face are large and elongated.

Eighth dorsal: With the exception of the distal portion of the neural spine, this vertebra (pl. 23, fig. 3) is essentially complete. From the preceding dorsal, this vertebra differs in having a pronounced enlargement of the rather thin laterally compressed metapophyses, irregular convex prezygapophysial facets, markedly reduced postzygapophysial facets, and more robust diapophyses located at a lower level. Each diapophysis (or coalesced diapophysis and merapophysis of Abel, 1931) projects outward from the pedicle of the neural arch and bears distally an ovoidal facet for the single-headed rib, the anteroposterior axis (18 mm.) being greater than the vertical (12.5 mm.) diameter; the anterior face of the diapophysis is concave in the dorsoventral direction and the posterior face is convex.

There is a noticeable increase in the length (42.6 mm.) of the centrum, and the width (33.7 mm.) of the posterior face slightly exceeds the width (32.5 mm.) of the anterior face. The pronounced lateral constriction of the centrum also resembles that of the preceding dorsal and the ventral ridge is quite similar. The pair of arterial foramina on the dorsal face are, however, smaller. The height (22 mm.) of the neural canal (pl. 24, fig. 4) anteriorly is equivalent to the width. The anteroposterior diameter of the pedicle of the neural arch exceeds that of the seventh dorsal and the backwardly projecting portion of the neural arch is approximately the same width as the former. The neural spine is relatively broad and inclined backward.

Ninth dorsal: This vertebra (pl. 23, fig. 4) is characterized by a short transverse process (parapophysis) with a distal enlargement to provide an increased surface for articulation with the single-headed ninth rib, a somewhat elevated and laterally compressed metapophysis, reduced neural canal, and broad neural spine.

The centrum is slightly longer (45.5 mm.) than the preceding dorsal,

and the width (34.5 mm.) of the posterior face exceeds the width (32.5 mm.) of the anterior face. The lateral faces of the centrum are strongly depressed and curve concavely from the anterior to the posterior epiphyses, resulting in the development of a sharp thin anteroposterior ventral ridge. The pair of arterial foramina on the dorsal face are smaller than those of the preceding centrum. The laterally compressed pedicles of the neural arch have a minimum anteroposterior length of 26.5 mm. Each parapophysis (pl. 25, fig. 1) projects outward but is situated only partially below the level of the dorsal surface of the centrum. The height (23 mm.) of the neural canal anteriorly exceeds slightly the width (21 mm.). The rather broad neural spine, inclined backward and irregularly thickened below the extremity, measures 40 mm. anteroposteriorly at the base.

Tenth dorsal: Elongated metapophyses, neural canal triangular in cross section, longer transverse processes (parapophyses) with increased distal enlargement, and longer centrum distinguish this dorsal (pl. 26, fig. 1) from the preceding vertebra. Although a perceptible increase in the length (50 mm.) of the centrum is observable, the width (35 mm.) of the posterior face as compared with the width (33.2 mm.) of the anterior face has not been materially changed. The depressed lateral faces of the centrum exhibit the concave end-to-end curvature of the preceding vertebrae, but the thin median ventral ridge is more strongly developed and the pair of arterial foramina on the dorsal face are further reduced in size. Each parapophysis (pl. 25, fig. 2) projects outward from the upper portion of the centrum and is expanded distally to provide a larger surface for articulation with the single-headed tenth rib.

The laterally compressed pedicles of the neural arch resemble more closely those of the following lumbars than of the dorsals. The height (23 mm.) of the neural canal anteriorly is greater than the width (18 mm.). An increase in the anteroposterior diameter (44 mm.) of the neural spine at the base and a slight decrease in the height as compared to the ninth dorsal is conformable to the anticipated transition from the dorsal to the lumbar type of vertebra; it should be noted that the anterior border of the distal end of this spine is eroded and consequently this portion of the spine was probably wider in its original condition.

No distinct prezygapophysial facets are observable and the area occupied by the postzygapophysial facets on the preceding dorsals is reduced to an irregular depression.

Lumbar Vertebrae

Five anterior lumbar vertebrae were found. Of these, one is of no value for comparative purposes, two lack portions of the neural spine,

and, on another, the distal end of the left transverse process is broken off. Four of these lumbar vertebrae appear to represent a consecutive series.

The centra are all longer than broad and progressively increase in length from the first to the fourth. All possess a strongly developed median ventral carina or keel, which increases in prominence from the first to the fourth. The transverse processes are expanded beyond the middle of their length and are rounded distally with the exception of those of the first lumbar which are obliquely truncated. From the first to the fourth lumbars the broad neural spines are nearly vertical and decrease in height. The minimum anteroposterior diameter of either pedicle of the neural arch exceeds one-half the length of the centrum. The neural canals are subtriangular in cross section and decrease in height from the first to the fourth. The thin lamina-like metapophyses are directed obliquely upward and forward and all project beyond the level of the anterior face of the centrum. The prezygapophysial facets are reduced to circular depressions. On these anterior lumbars the backwardly projecting dorsal portion of the neural arch, however, does not extend beyond the level of the posterior face of the centrum.

In contrast to the lumbar vertebrae of *Delphinodon dividum* (True, 1912, pl. 23, figs. 1–6), these vertebrae have more elongated centra, broader neural spines, wider neural canals, and distally expanded transverse processes.

First lumbar: The right metapophyses and the tip of the right transverse process are missing. The centrum is elongated (pl. 26, fig. 2) and the strongly depressed lateral faces are separated ventrally by the thin longitudinal ridge. The pair of arterial foramina on the dorsal face are rather small. The transverse processes are elongated (85 mm.) and exceed in length those of the following lumbars; the distal half of each process is obliquely truncated anteriorly, terminating in an irregular roughened area on the posteroexternal angle. It is quite possible that this rugose surface may have served as an area for the attachment of a floating rib. The height (24 mm.) of the neural canal (pl. 28, fig. 1) anteriorly exceeds the width (18 mm.). On each side the pedicle of the neural arch occupies about two-thirds (37 mm.) the length (56 mm.) of the centrum. The left metapophysis is directed upward and forward, and projects beyond the anterior face of the centrum. The prezygapophysial facets are roughened and are located below the level of the base of the neural spine. The anterior margin of the rather broad neural spine exhibits a more noticeable concave curvature than the posterior margin.

Second lumbar: This vertebra (pl. 26, fig. 3) differs from the first lumbar as follows: the centrum is slightly longer (58.5 mm.) and wider anteriorly (35.5 mm.), the transverse processes are shorter, and the neural spine is broader. The right metapophysis is missing. The left metapophysis does not project as far forward as that of the preceding lumbar, and the prezygapophysial facet, which is located below the level of the base of the neural spine, is reduced to a circular depression. A sharp ventral longitudinal ridge or carina forms the dividing line between the deeply depressed lateral surfaces of the centrum. The pair of arterial foramina on the dorsal face are very small. As compared to the first lumbar the anteroposterior diameter (35 mm.) of the pedicle of the neural arch at the base is slightly shorter, the height (25 mm.) of the neural canal (pl. 28, fig. 2) anteriorly has increased slightly and the width (17.5 mm.) has decreased, and the backwardly projecting dorsal portion of the neural arch may have been shorter since it terminates in its present condition at least 10 mm. anterior to the level of the posterior face of the centrum. The rather broad neural spine is directed almost vertically. It should be noted that the anterior border of the distal portion of the neural spine is slightly eroded, although it is unlikely that this has materially altered the contour. The rather broad transverse processes increase in width beyond the basal constriction, and exhibit a nearly straight posterior edge, a rounded extremity, and an oblique truncation of the anterior border on the distal half of the length.

Third lumbar: On this vertebra (pl. 27, fig. 1) the distal portion of the neural spine is destroyed, the left metapophysis is broken off, and the posteroexternal angle of the left transverse process is missing. As compared to the preceding vertebra, the centrum has increased very slightly in length. In the development of the longitudinal ventral keel and the side-to-side compression this centrum agrees rather closely with that of the preceding lumbar. The width (38 mm.) of the posterior face is slightly greater than the width (36 mm.) of the anterior face and the pair of arterial foramina on the dorsal face are small. The pedicles of the neural arch do not differ materially from the preceding lumbar, and the backwardly projecting dorsal portion of the neural arch does not extend posteriorly to the level of the posterior face of the centrum. The neural spine is not quite so broad anteroposteriorly as the preceding. The elongated and rather slender right metapophysis projects conspicuously beyond the level of the anterior face of the centrum and the prezygapophysial facet is restricted to a small depression located near the posteroventral angle of this process. The transverse processes (pl. 29, fig. 1) are slightly expanded on the distal half and have rounded extremities.

Fourth lumbar: Of this lumbar (pl. 27, fig. 2), the right metapophysis is incomplete, all of the neural spine with the exception of the small basal fragment is missing, and the distal half of the left transverse process is broken off. The centrum is slightly longer (61 mm.) and broader posteriorly (39.5 mm.) than the prceding lumbar, the longitudinal ventral carina or keel is more strongly developed, and the side-to-side compression accentuates the anteroposterior concave curvature of the lateral faces. The neural canal (pl. 29, fig. 2) is reduced in height and breadth. The right transverse process is less noticeably expanded distally than that of the preceding lumbar and is rounded at the extremity. Since a portion of the neural arch is incomplete it is quite possible that the slender elongated metapophysis has been incorrectly placed in the restoration of the missing portions. An irregularly depressed small circular area on the posteroventral border of this metapophysis represents the prezygapophysial facet.

Indeterminate lumbar: This vertebra (pl. 27, fig. 3) is too incomplete for the determination of its position in the lumbar series. Basal portions of the transverse processes and a small section of the anterior face of the centrum are preserved. The right transverse process does not differ materially from the basal portion of this process on the third lumbar.

Measurements of cervical vertebrae (in millimeters)

	Axis	C-3	C-4	C-5	C-6	C-7
Greatest height (vertically) of vertebra (tip of neural spine to ventral face of centrum)	89.0	52.3	53.7	50.2	53.2	
Greatest distance across vertebra between outer margins of anterior articular surfaces	63.0					
Least anteroposterior diameter of dorsal surface of neural arch	17.0	6.5	8.5	6.7	6.6	9.0
Least anteroposterior diameter of pedicle of neural arch	10.0	5.5	5.7	7.4	10.5	14.2
Greatest vertical diameter of anterior face of centrum	26.5*	29.0	29.7	30.8	31.2	30.5
Greatest transverse diameter of anterior face of centrum	40.0*	35.2	35.0	32.4	32.3	31.5
Distance across vertebra between outer ends of diapophyses						72.0
Distance across vertebra between outer ends of transverse processes	87.+			62.8	60.5	
Transverse diameter of neural (spinal) canal anteriorly	23.0	21.5	19.0	19.5	20.7	24.0
Vertical diameter of neural (spinal) canal anteriorly	23.7	16.0	17.0	15.0	16.0	
Greatest distance between outer margins of prezygapophysial facets			36.6	36.7	37.0	42.3
Greatest distance between outer margins of postzygapophysial facets		34.2	34.0	36.2	38.0	48.2
Distance between tip of prezygapophysis and tip of postzygapophysis		18.0	20.7	22.0	23.7	24.5

* Posterior face.

MEASUREMENTS OF DORSAL VERTEBRAE (IN MILLIMETERS)

	D–1	D–2	D–3	D–4	D–5	D–6	D–7	D–8	D–9	D–10
Greatest height (vertically) of vertebra (tip of neural spine to ventral face of centrum)	80. 5	105. 3	103. 5	120. 0	107. 6	88. 0+	83. 0+	111. 0+	125. 0	122. 0
Vertical height of neural spine, dorsal surface of neural canal to tip of neural spine	34. 2	57. 0	55. 5	74. 0	60. 5	43. 0+	44. 7+	71. 5+	83. 5	75. 0
Anteroposterior diameter of centrum	19. 5	23. 4	27. 5	30. 5	32. 2	34. 2	38. 0	42. 6	45. 5	50. 0
Greatest vertical diameter of anterior face of centrum	29. 3	25. 0	24. 5	25. 2	26. 2	27. 8	27. 3	28. 7	29. 0	31. 2
Greatest transverse diameter of anterior face of centrum	32. 0	30. 5	30. 7	30. 0	29. 5	30. 2	31. 8	32. 5	32. 5	33. 2
Greatest vertical diameter of neural (spinal) canal anteriorly	18. 0	22. 0	23. 5	25. 0	24. 8	24. 0	23. 0	22. 0	23. 0	23. 0
Greatest transverse diameter of neural (spinal) canal anteriorly	22. 5	23. 0	25. 0	25. 0	24. 5	24. 3	24. 0	22. 0	21. 0	18. 0
Least anteroposterior diameter of pedicle of neural arch	10. 0	10. 6	13. 0	12. 7	11. 8	13. 7	17. 5	21. 8	26. 5	27. 8
Distance across vertebra between outer ends of diapophyses	74. 5			65. 7	67. 3	67. 0	62. 0+	72. 8		
Distance across vertebra between outer ends of parapophyses									82. 5	103. 5
Greatest distance between outer margins of prezygapophysial facets	52. 3			45. 0	40. 4	34. 0	27. 0	21. 0	16. 0	12. 0
Greatest distance between outer margins of postzygapophysial facets	43. 5	39. 0+	38. 7	36. 8	29. 2	20. 0	15. 0	10. 0		
Distance between anterior edge of prezygapophysial facet and posterior edge of postzygapophysial facet	38. 2	41. 8	44. 8	45. 8	49	54. 2	55			
Distance between tip of metapophysis and posteroventral angle of neural spine								58. 8	61. 0	68. 7

MEASUREMENTS OF LUMBAR VERTEBRAE (IN MILLIMETERS)

	L-1	L-2	L-3	L-4	L-5
Greatest height (vertically) of vertebra (tip of neural spine to ventral face of centrum)	131. 4	127. 0	114. 0+	84. 0+	
Vertical height of neural spine, dorsal surface of neural canal to tip of neural spine	81. 0	73. 5	60. 0+		
Anteroposterior diameter of centrum	56. 0	58. 5	59. 4	61. 0	46. 0
Greatest vertical diameter of anterior face of centrum	35. 0	34. 3	35. 4	37. 0	
Greatest transverse diameter of anterior face of centrum	31. 8	35. 5	36. 0	36. 4	41. 0±
Greatest vertical diameter of neural (spinal) canal anteriorly	24. 0	25. 0	21. 0	16. 0	
Greatest transverse diameter of neural (spinal) canal anteriorly	18. 0	17. 5	16. 4	14. 0	
Least anteroposterior diameter of pedicle of neural arch	34. 8	30. 5	31. 0	34. 0	
Distance across vertebra between outer ends of transverse processes (parapophyses)	195. 0+	179. 5	179. 0	143. 2+	112. 0±
Distance between tip of metapophysis and posteroventral angle of neural spine	75. 0	65. 0	78. 0	58. 0+	

RIBS

Nine identifiable ribs and distal portions of two others were associated with the vertebrae. The ribs were not found in normal relation to the dorsal vertebrae when the bones were excavated and their position was determined by articulations with the vertebrae. Only the first rib (pl. 30, fig. 1) from the left side is essentially complete. As compared with the ribs that follow in the series, this first rib is relatively short, rather broad, and strongly flattened anteroposteriorly. The capitulum is rounded, larger than those of the second to sixth ribs, and its articular surface is rugose. The neck is short and flattened anteroposteriorly. The tuberculum is elongated (22.5 mm.), convex from side to side, with greatest width (12. 5 mm) posteriorly. The greatest width of the shaft (35 mm.) is immediately behind the tuberculum. The shaft is abruptly bent downward behind the angle and its ventral end is slightly twisted inward and enlarged internally to provide the rugose surface for attachment to the sternum.

The right and left second ribs (pl. 30, figs. 2, 5) lack the distal portions of the shafts. On both ribs the small, rounded capitula are borne upon short necks which are bent slightly upward. The tuber-

culum is elongated, subtriangular in outline, and with greatest width (10.5 mm.) posteriorly. The outer surface of the shaft is flattened and transversely widened in the region of the angle, with the protruding edge overhanging the posterior surface. Below the angle the shaft is flattened anteroposteriorly and its inner and outer edges are thin and somewhat irregular. The greatest width (21.5 mm.) of the right rib, as preserved, is near the posterior end of the angle, and its end-to-end curvature is more pronounced than that of the first rib.

The third rib (pl. 30, fig. 6) on the right side lacks the distal portion of the shaft, but is otherwise complete. This rib is characterized in part by a more strongly curved slender shaft, its outer edge being thin and its inner edge somewhat rounded at least on the proximal portion. The outer surface of the shaft is also transversely widened in the region of the angle, with the protruding edge overhanging the posterior surface for a greater distance than on the second rib. The capitulum is elongated, subtriangular in outline, bent upward, and with its articular surface roughened. The neck is narrower and longer than that of the second rib. The elongated tuberculum is subtriangular in outline, concave from end to end, and convex from side to side.

Less than one-third of the fourth rib (pl. 30, fig. 7) on the right side is preserved, and it lacks not only the distal portion of the shaft but the neck and capitulum as well. The fourth rib on the left side lacks the distal portion of the shaft. The shaft is slightly narrower than that of the third rib; the normal widening of the thorax in this region results in a lengthening of the interval between the tuberculum and the angle, and the overhang of the outer edge in this region is less noticeable. The tuberculum is subovoidal in outline and slopes downward from anterior to posterior margins. The neck is slightly longer than that of the third rib and its dorsoventral diameter is reduced. The capitulum is relatively small. The outer edge of the shaft is thin and the inner surface rounded.

The right and left ribs of the sixth pair (pl. 30, figs. 4, 8) are characterized by a slender shaft, an elongated neck, a small capitulum, and a subovoidal tuberculum which slopes downward from anterior to posterior margins. The outer surface of the shaft is transversely widened between the tuberculum and the angle, with the protruding edge overhanging the posterior surface for a greater distance than on any of the preceding ribs. Below the level of the angle the inner surface of the shaft is rounded; the outer edge is thin and irregular.

The proximal portion of the seventh rib (pl. 30, fig. 9) above the angle is missing. The outer surface of the shaft is transversely widened above the angle and the protruding edge overhangs the posterior face as on the preceding rib. The outer edge of the slender

shaft is thin and the inner surface rounded. At some time in the life of this porpoise this rib was broken approximately 125 mm. distal to the angle, and the resulting rugose enlargement of this broken end indicates that the break with the distal portion did not subsequently heal.

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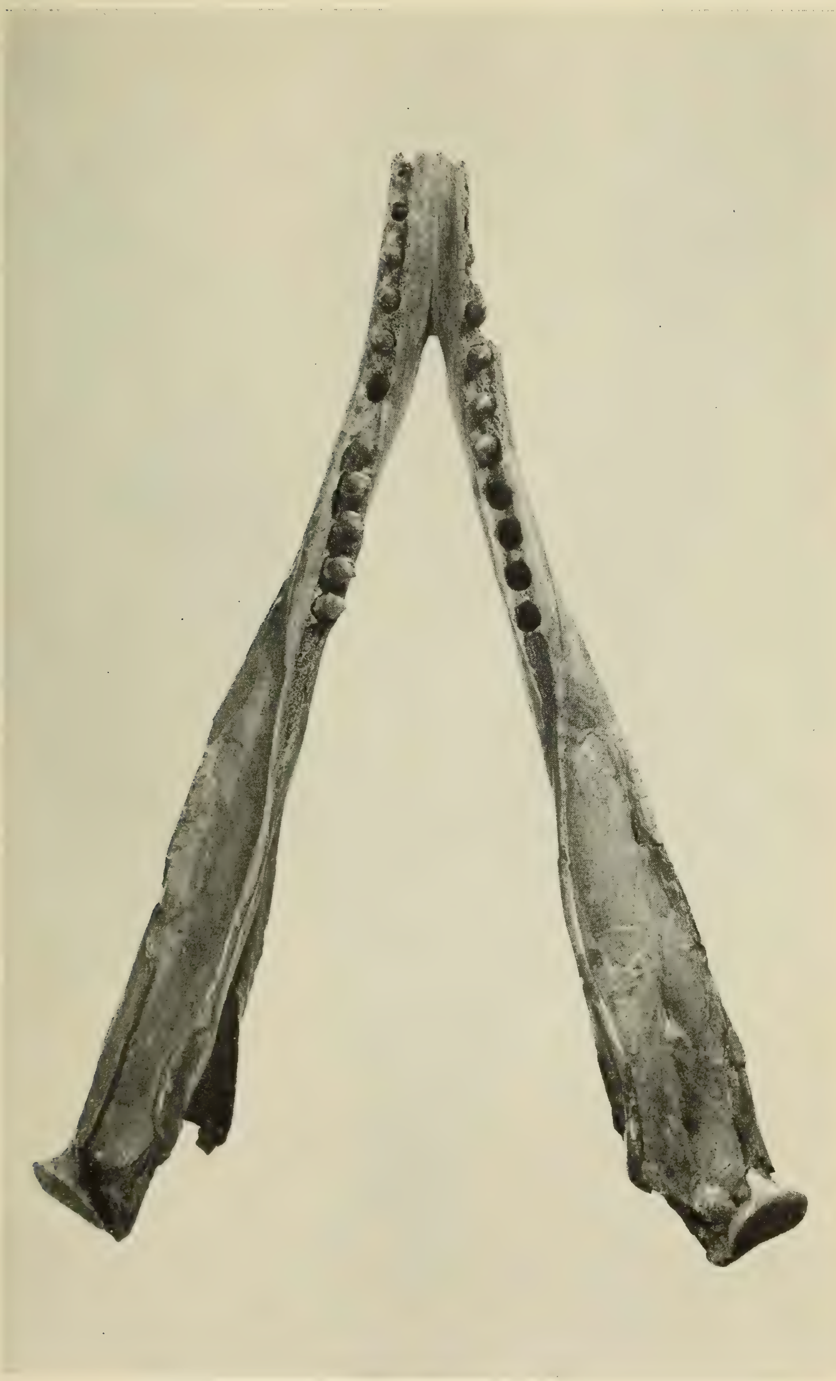
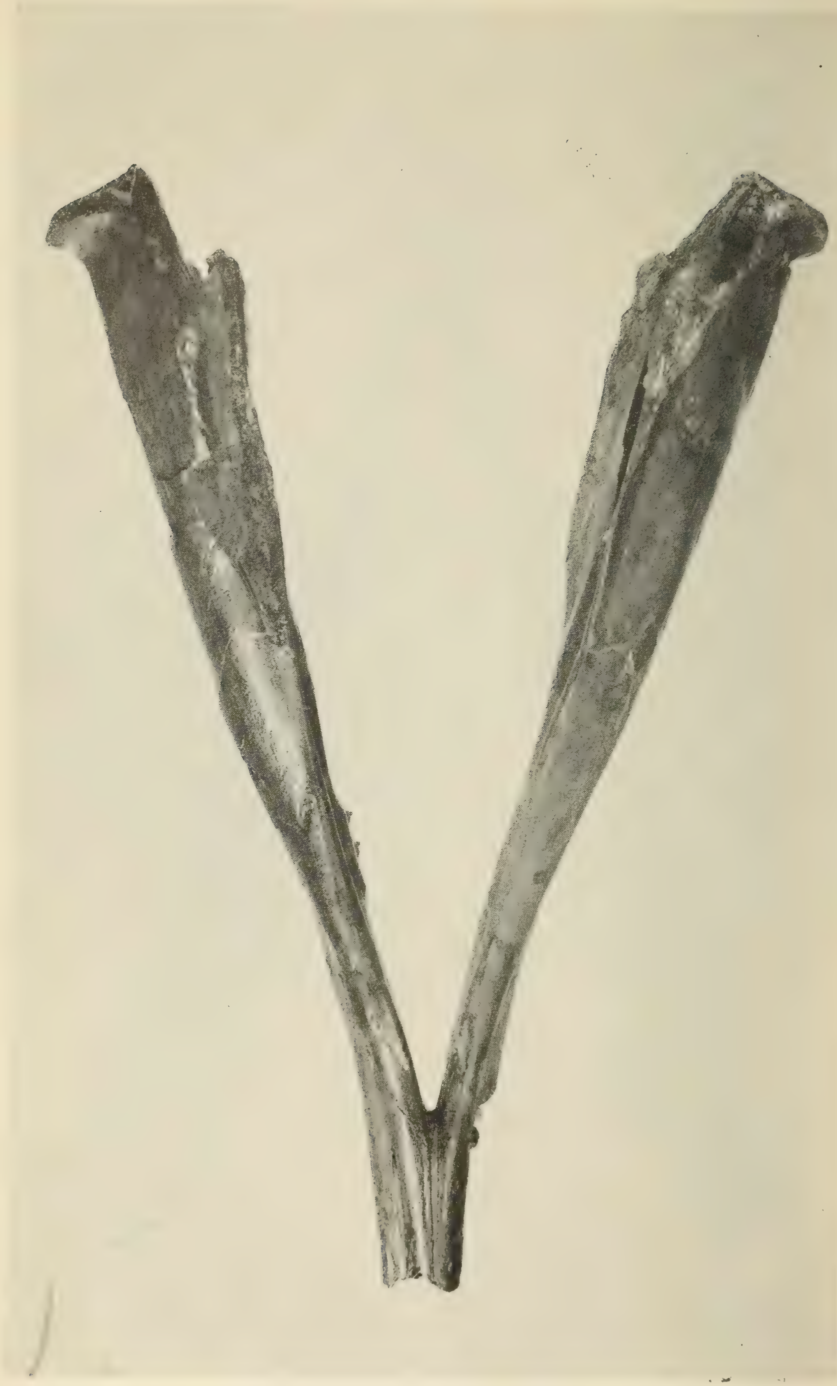


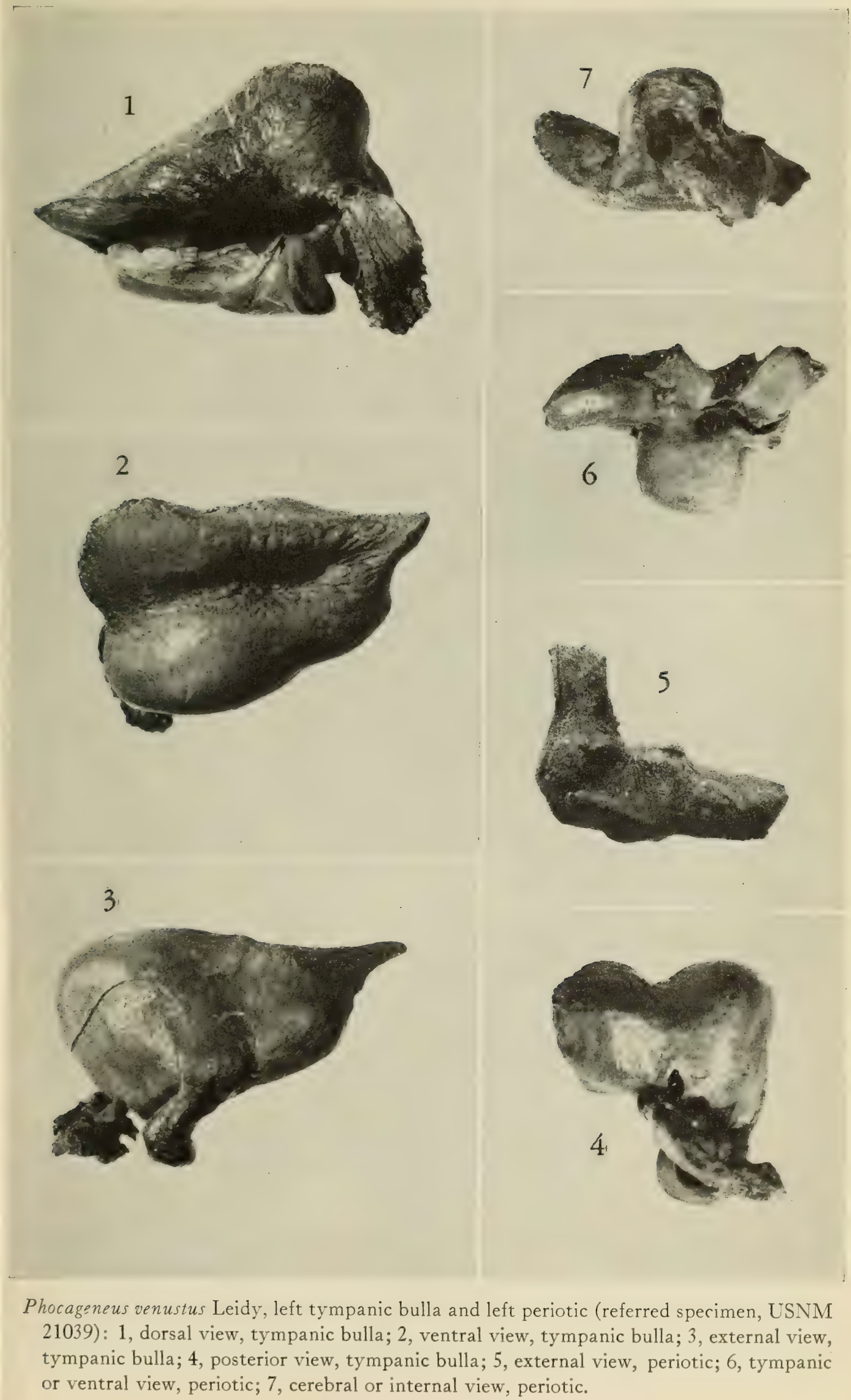
Phocageneus venustus Leidy (referred specimen, USNM 21039), dorsal view of mandibles.



Phocageneus venustus Leidy (referred specimen, USNM 21039), ventral view of mandibles.

Phocageneus venustus Leidy, type tooth (ANSP 11227): 1, external view; 2, posterior view; 3, internal view. Referred teeth (USNM 20139): 4, external view, eleventh tooth, right; 5, internal view, sixth, left; 6 internal view, fourth, right. All X 2.

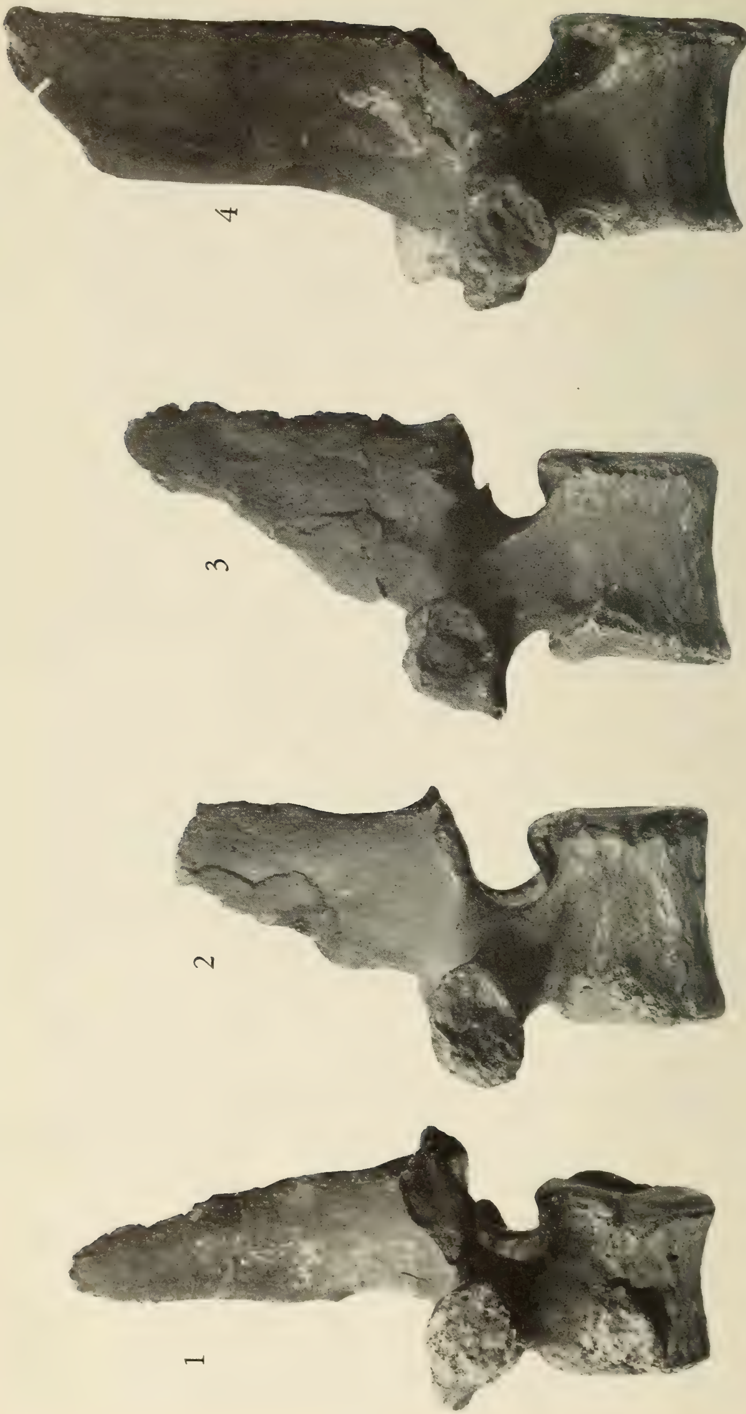
Phocageneus venustus Leidy, teeth (referred specimen, USNM 20139): 1, internal view, tenth tooth, left; 2, internal view, second, right; 3, internal view, hindmost, ? right; 4, internal view, hindmost, ? right; 5, internal view, twelfth or thirteenth, right; 6, external view, eleventh, left. Figure 4, X 4; all others X 2.



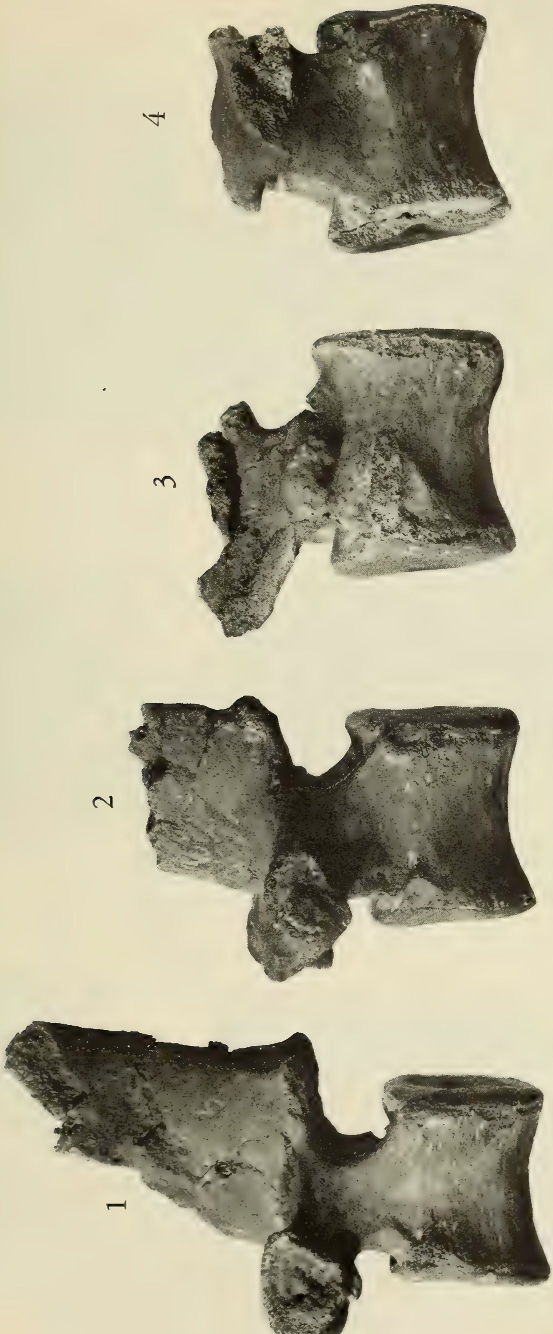
Phocageneus venustus Leidy, left tympanic bulla and left periotic (referred specimen, USNM 21039): 1, dorsal view, tympanic bulla; 2, ventral view, tympanic bulla; 3, external view, tympanic bulla; 4, posterior view, tympanic bulla; 5, external view, periotic; 6, tympanic or ventral view, periotic; 7, cerebral or internal view, periotic.

Phocageneus venustus Leidy, right tympanic bulla and right periotic (referred specimen, USNM 21039): 1, external view of tympanic bulla and periotic; 2, cerebral or internal view of tympanic bulla and periotic; 3, posterior view of tympanic bulla and periotic.

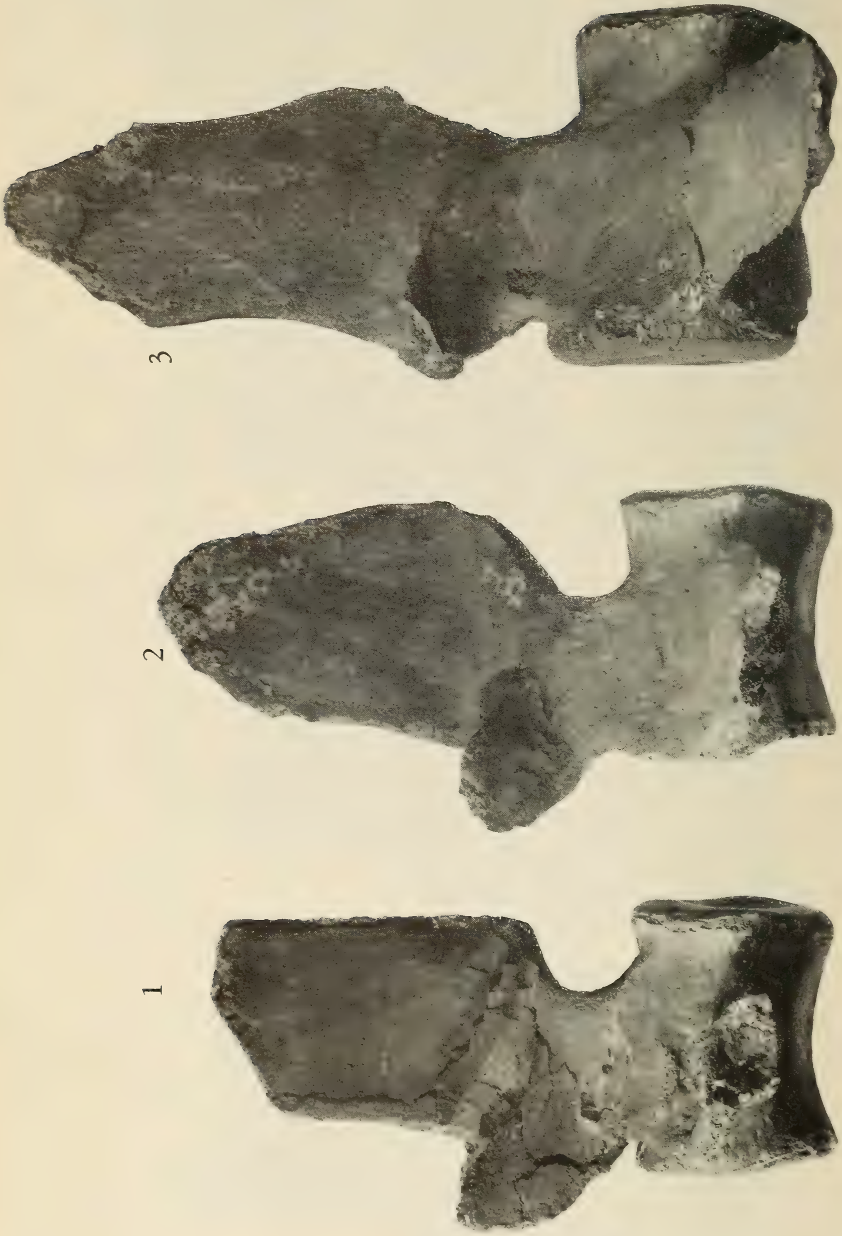
Phocageneus venustus Leidy (referred specimen, USNM 21039): 1, anterior view, sixth cervical; 2, anterior view, third cervical; 3, anterior view, atlas; 4, anterior view, fifth cervical.



Phocageneus venustus Leidy (referred specimen, USNM 21039): 1–4, lateral views of first, second, third, and fourth dorsals, respectively.



Phocageneus venustus Leidy (referred specimen, USNM 21039): 1–4, lateral views of fifth, sixth, seventh and eighth (reversed) dorsals, respectively.

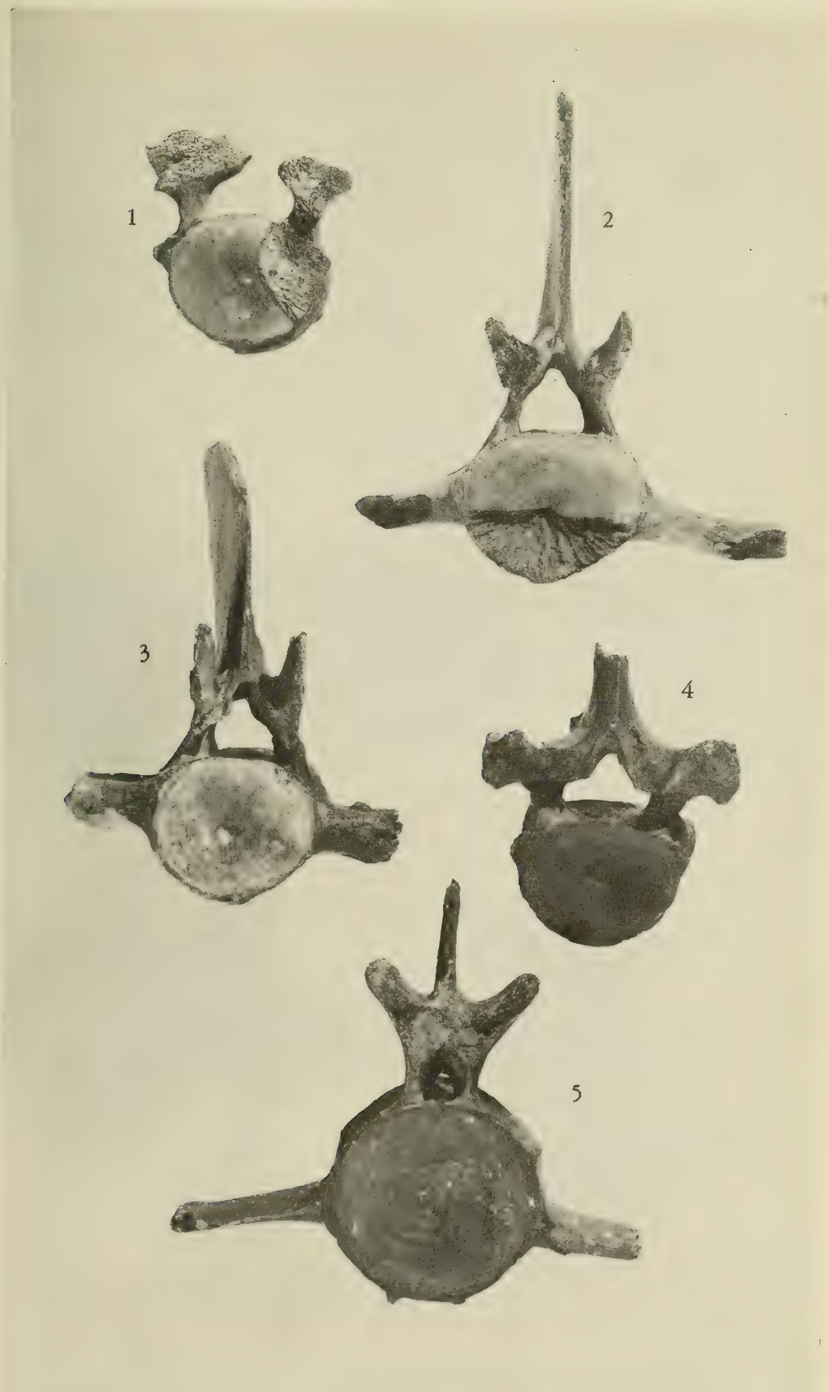


Phocageneus venustus Leidy (referred specimen, USNM 21039): 1 and 2, lateral views of ninth and tenth dorsals; 3, lateral view of anterior lumbar.

1 2 3

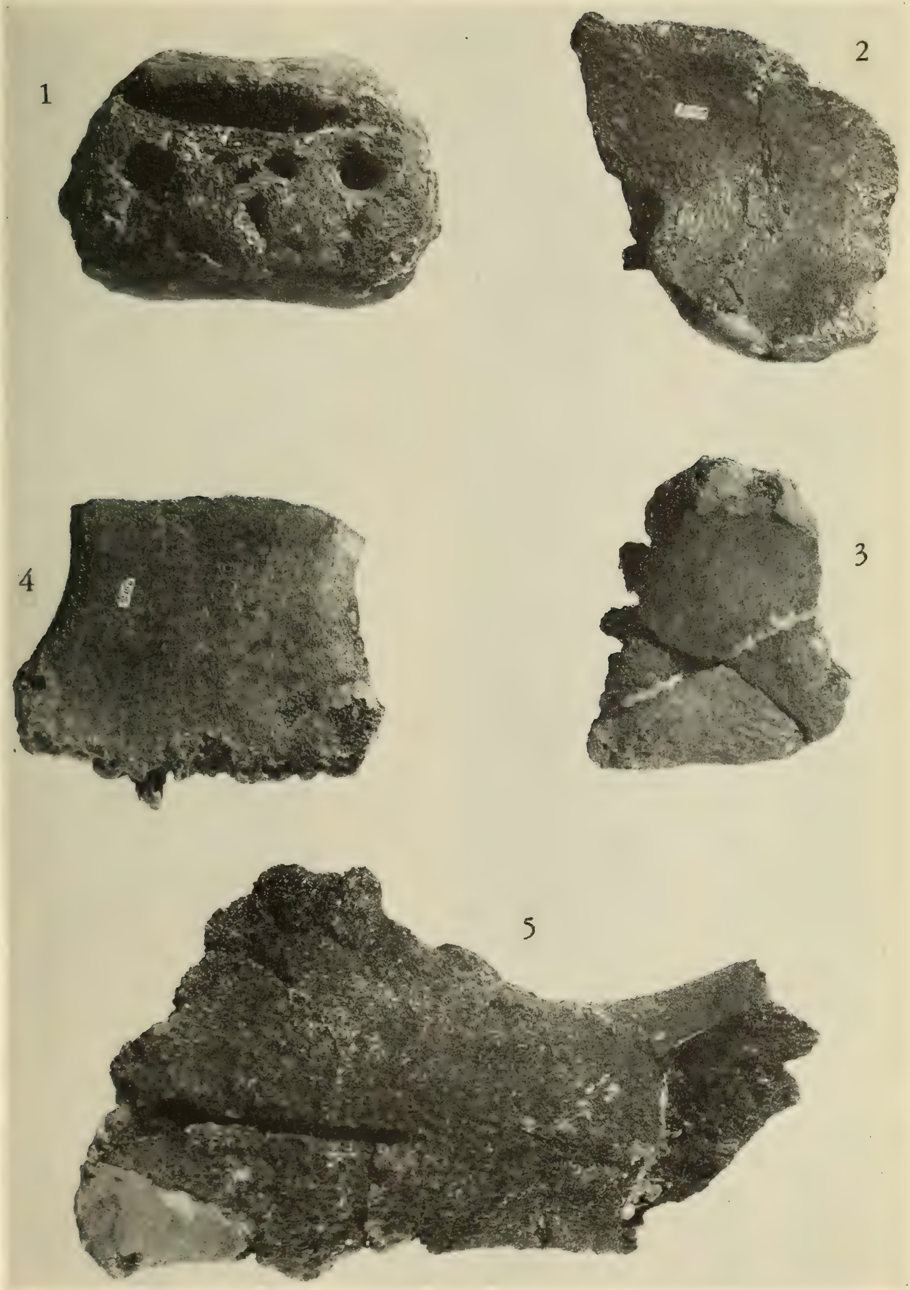
Phocageneus venustus Leidy (referred specimen, USNM 21039): 1–3, lateral views of caudals.

Phocageneus venustus Leidy (referred specimen, USNM 21039): 1–6, anterior views of first, second, third, fourth, fifth, and seventh dorsals, respectively.



Phocageneus venustus Leidy (referred specimen, USNM 21039): 1–4, anterior views of eighth, tenth, ninth, and sixth dorsals, respectively; 5, anterior view of caudal.

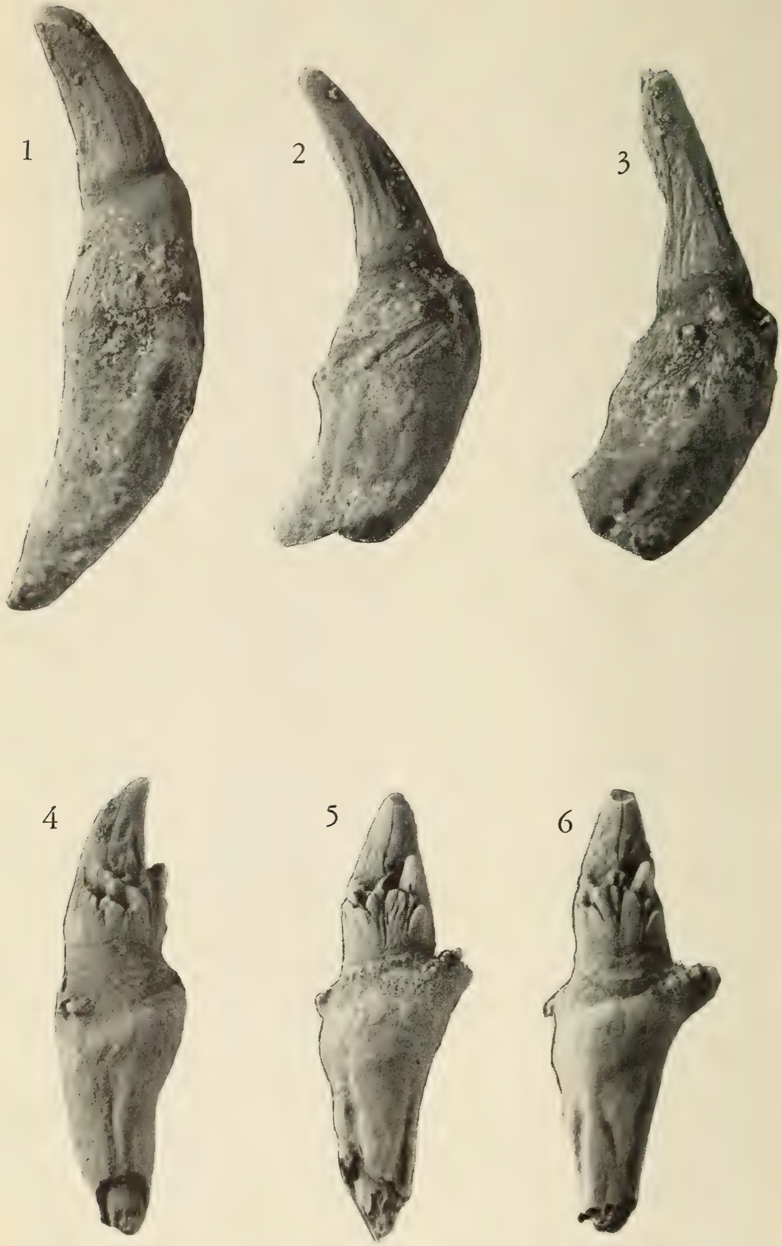
Phocageneus venustus Leidy (referred specimen, USNM 21039): 1, anterior view of lumbar; 2 and 3, anterior views of caudals.



Phocageneus venustus Leidy (referred specimen, USNM 21039): 1, dorsal view of terminal caudal; 2 and 3, lateral views of chevrons; 4 and 5, segments of sternum.

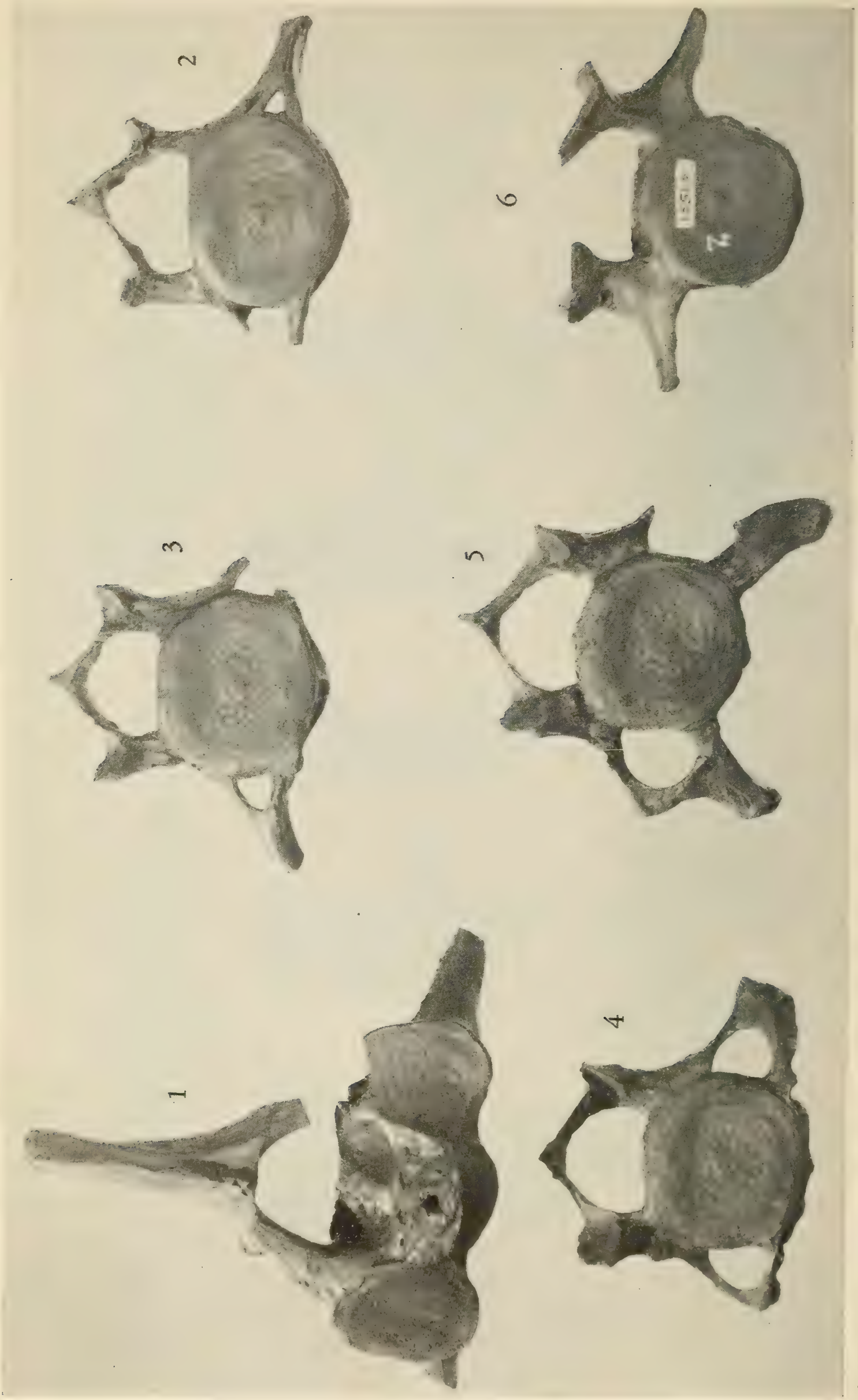
Araeodelphis natator, new genus, new species (type, USNM 10478): 1, lateral view of rostrum and mandibles; 2, ventral view of rostrum; 3, dorsal view of mandibles.

Araeodelphis natator, new genus, new species (type, USNM 10478): 1, dorsal view of rostrum; 2, ventral view of mandibles.



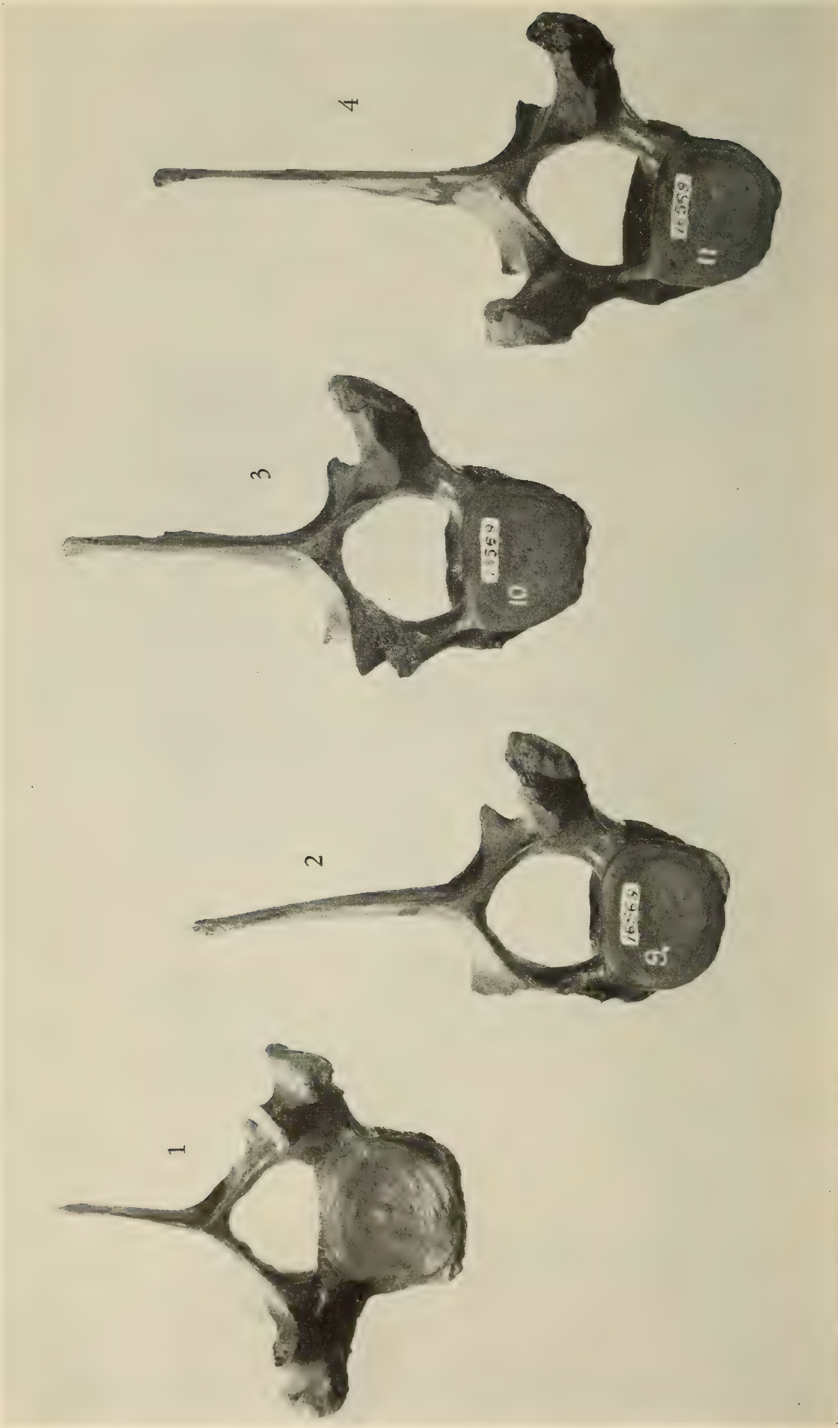
Araeodelphis natator, new genus, new species (type, USNM 10478).: 1–3, internal views of anterior teeth; 4–6, internal views of posterior teeth.

Araeodelphis natator, new genus, new species (referred specimen, USNM 16569): 1–6, lateral views of axis and third, fourth, fifth. sixth, and seventh cervicals, respectively.



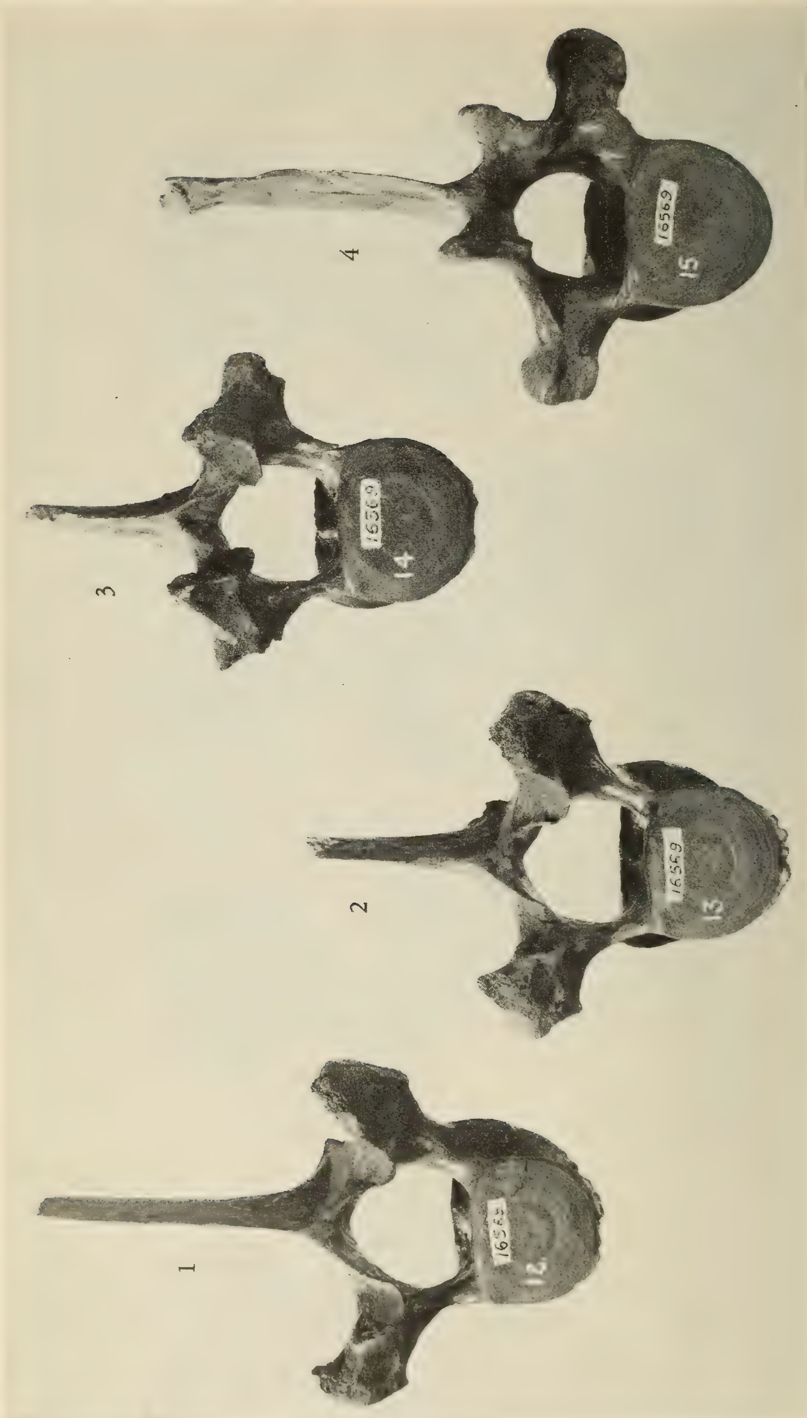
Araeodelphis natator, new genus, new species (referred specimen, USNM 16569): 1–6, anterior views of axis and third, fourth, fifth, sixth, and seventh cervicals, respectively.

Araeodelphis natator, new genus, new species (referred specimen, USNM 16569): 1–5, lateral views of first, second, third, fourth, and fifth dorsals, respectively.



Araeodelphis natator, new genus, new species (referred specimen, USNM 16569): 1–4, anterior views of first, second, third, and fourth dorsals, respectively.

Araeodelphis natator, new genus, new species (referred specimen, USNM 16569): 1–4, lateral views of sixth, seventh, eighth, and ninth dorsals, respectively.



Araeodelphis natator, new genus, new species (referred specimen, USNM 16569): 1–4, anterior views of fifth, sixth, seventh, and eighth dorsals, respectively.

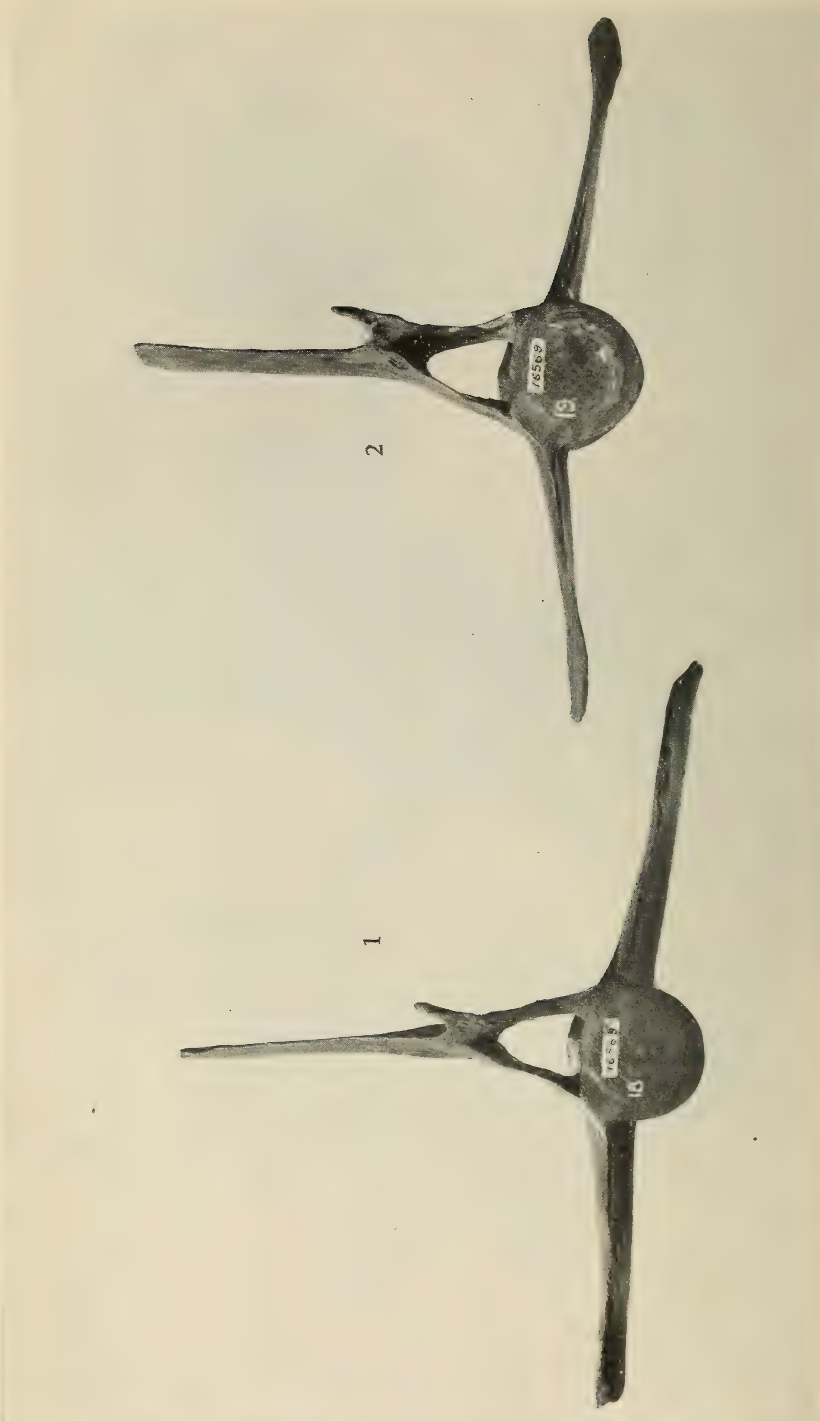
Araeodelphis natator, new genus, new species (referred specimen, USNM 16569): 1 and 2, anterior views of ninth and tenth dorsals, respectively.

1 2 3

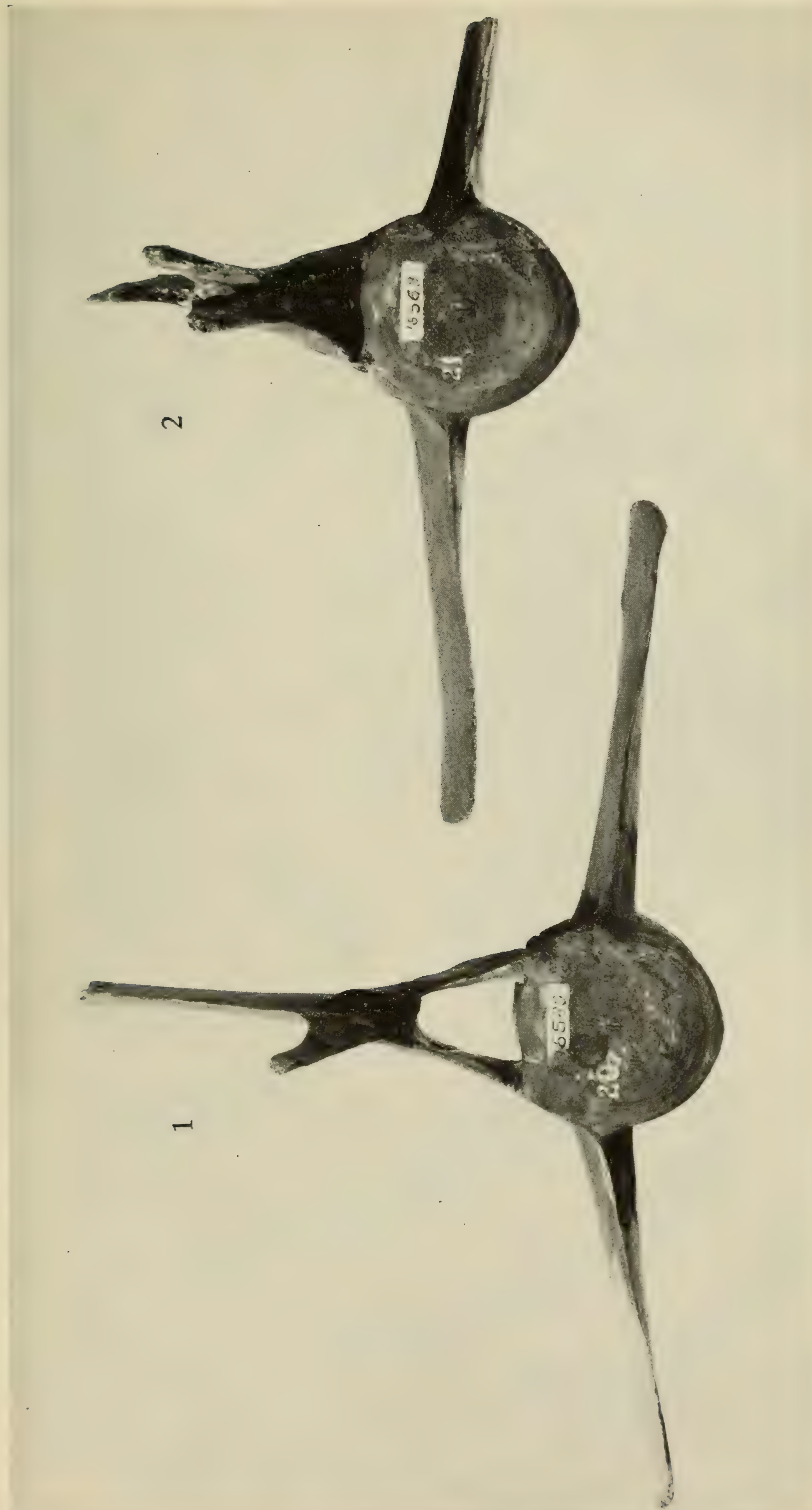
Araeodelphis natator, new genus, new species (referred specimen, USNM 16569): 1–3, lateral views of tenth dorsal and first and second lumbars, respectively.

1 2 3

Araeodelphis natator, new genus, new species (referred specimen, USNM 16569): 1–3, lateral views of third, fourth, and indeterminate lumbar, respectively.



Araeodelphis natator, new genus, new species (referred specimen, USNM 16569): 1 and 2, anterior views of first and second lumbars, respectively.



Araeodelphis natator, new genus, new species (referred specimen, USNM 1656[9]): 1 and 2, anterior views of third and fourth lumbars, respectively.

Araeodelphis natator, new genus, new species (referred specimen, USNM 16569): 1, first rib, left; 2, second rib, left; 3, fourth rib, left; 4, sixth rib, left; 5, second rib, right; 6, third rib, right; 7, fourth rib, right; 8, sixth rib, right; 9, seventh rib, right.

STUDIES OF SEVEN SIDERITES

BY

EDWARD P. HENDERSON AND STUART H. PERRY

No. 3388.—From the Proceedings of the United States National Museum
Vol. 107, pp. 339–403, 6 figs., 22 pls.

SMITHSONIAN INSTITUTION

WASHINGTON : 1958

Stuart H. Perry

Stuart Hoffman Perry died on February 15, 1957, in Tucson, Ariz. He was the publisher of the Adrian Telegram and vice president of the Monroe Evening News, both well known Michigan newspapers. From April 1940 he was an associate in mineralogy at the U. S. National Museum.

Perry was born October 13, 1874, in Pontiac, Mich., and while very young showed an interest in science. At 15 he presented a paper on rhizopods before the American Microscopical Society. In 1894 he graduated from the University of Michigan, where he studied chemistry, geology, and zoology. Two years later he graduated from the University of Michigan Law School, and for nearly five years practiced law in Detroit. In 1901 he entered newspaper work. After a few years of publishing various papers in Michigan he purchased an interest in the Adrian Telegram, and a few years later an interest in the Monroe Evening News.

Fossils were one of Perry's early scientific pursuits, but when someone showed him a meteorite and asked some questions about it his reply was that he did not know but that he would look into that subject. From that moment on, Perry's scientific interests were essentially directed towards the study of meteorites. He was both a keen student of meteorites and a vigorous collector of them. However, the unique thing about his collecting was that almost as soon as he became the owner of a meteorite he was concerned with giving the specimen to a collection where it would help others in the study of meteorites.

In 1944 the U. S. National Museum published Bulletin 184, Perry's "Metallography of Meteoritic Iron." Shortly thereafter Perry compiled and privately published five albums of photomicrographs on meteorites, the background of the study on which Bulletin 184 was based. Because of the excessive costs of this publication, the album series was limited to six sets. Later the album series was expanded to nine volumes, in which the studies on 166 meteorites were reported and 2,308 photomicrographs presented.

In 1946 the National Academy of Science awarded Perry the J. Lawrence Smith gold medal for his investigations on meteorites. Through the years that Perry was studying and collecting meteorites he generously shared his knowledge and specimens with others. Although he presented specimens to many institutions and privately assisted others in their studies of meteorites, he was sincerely interested in the growth of the national collection of meteorites and presented what he considered to be his important specimens to the U. S. National Museum. During his life Perry donated 192 different meteorites to the national collections.


(Photo by Fabian Bachrach)

Stuart Hoffman Perry
1874–1957

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STUDIES OF SEVEN SIDERITES

By Edward P. Henderson and Stuart H. Perry

Introduction

These seven descriptions are some of the investigations the authors made between 1940 and 1956. Some of these observations formed the background study to U. S. National Museum Bulletin 184, by S. H. Perry, published in 1944. After that volume was published, a limited number of albums of photomicrographs on iron meteorites with interpretations were also privately published by S. H. Perry and given a limited distribution. These nine volumes are now available in the following institutions: American Museum of Natural History; Chicago Museum of Natural History; Mineralogical Museum, Harvard University; U. S. National Museum; Mineralogical Museum, University of Michigan; and British Museum (Natural History).

During these studies our findings sometimes differed from the data that others had published on the same meteorites, and we suggested that a reexamination should be made. The divergences were found in the descriptions of specimens, chemical analyses, the assignment of types and the identifications of conspicuous minerals.

Some of these findings confirm data published by others and some correct errors in earlier descriptions. Two of the studies are descriptions of undescribed irons.

The undescribed meteorites are the Goose Lake, California, and the Keen Mountain, Virginia, irons. The former was found in 1938, and although it had been pictured in several publications, its unique surface features were not described properly. The Keen Mountain iron was found in 1950 and is not as well known. The main masses of both meteorites are in the U. S. National Museum.

The investigations on the Cincinnati, Pittsburgh, Breece, Tombigbee, and Soroti meteorites are restudies of described specimens.

Appreciation is expressed to all who have helped in various ways in this study. The investigation of these meteorites began many years ago and presented a variety of problems that were discussed with many workers. We may have failed to give credit to all the contributors to this work, but we hope this is not the case.

Among the many who have made important contributions and whom we wish to thank for their assistance are Prof. H. H. Uhlig of Massachusetts Institute of Technology; Dr. Walter Curvello of Museum National, Rio de Janerio, Brazil, who was a visitor in the U. S. National Museum when some of these investigations were in progress; Dr. Frederick H. Pough, formerly of the American Museum of Natural History; R. O. Roberts of Uganda for providing samples of the Soroti meteorite; Dr. Clifford Frondel of Harvard College and Dr. Carl Dunbar of Yale University for the loan of samples of the Pittsburgh meteorite; Dr. Gunard Kullerud of the Carnegie Institute Geophysical Laboratory; and Dr. George Ellinger of U. S. National Bureau of Standards.

The Goose Lake, California, Meteorite

Plates 1–9

While deer hunting west of Goose Lake, Modoc County, Calif. (lat. 41°58′ N., long. 120°32′ W.), on Oct. 13, 1938, Clarence Schmidt, Joseph Secco, and Ira Ivers discovered a large, irregular, rounded object that proved to be the fourth largest iron meteorite thus far reported from this country. The U. S. National Museum acquired this specimen through the cooperation of Clarence Schmidt, acting as agent for the finders, and the U. S. Forest Service, on whose land the specimen was found.

The details of discovery and removal of the specimen to San Francisco, Calif., have already been published (Leonard, 1939a, 1939b, 1940, 1950; Linsley, 1939a, 1939b). The specimen was displayed during the 1939 and 1940 seasons of the International Exposition at

Treasure Island, Calif.; when the Exposition closed, the sample was shipped to the U. S. National Museum.

Any description of the Goose Lake iron that neglected to discuss the cavities would be incomplete. The description of this meteorite and its cavities is not controversial, but our discussion of the origin and significance of the cavities definitely is controversial. Although we are not qualified to work in the sciences needed to explain the origin of these cavities, we have made this study available to many persons working in other sciences and have stimulated considerable thinking about cavities in meteorites. Our opinions about the origin of these cavities are not in accord with the thinking of F. L. Whipple and R. N. Thomas, whose comments have been given mainly by informal communications.

At the Boston meetings of the American Association for the Advancement of Science in 1953, Thomas discussed some of our theories and raised some challenging points. His objections are not entirely convincing, but on the other hand we are not completely satisfied with our own theories concerning the origin of cavities in the Goose Lake iron. We hope that this paper will stimulate more discussion on this important feature of meteorites.

After the Boston meetings the authors discussed the problem with J. M. Kendall, U. S. Naval Ordnance Laboratory, Silver Spring, Md., and with C. H. McLellan and William J. O'Sullivan from Langley Aeronautical Laboratory, Langley Field, Va. Actually, the topics in this study have been so widely discussed with others that it is becoming difficult properly to credit the suggestions. We are grateful for the interest others have taken.

Description

The Goose Lake meteorite measures 46 x 29 x 20 inches and weighs 2,573 pounds. Its surface, although comparatively fresh, is covered with a thin, firm layer of brown iron oxide, but in many places flight markings are still preserved. The appearance of this iron would seem to indicate that it fell a few years before its discovery but long enough ago for the black crust of a freshly fallen iron to rust.

The thin films of deformed metal that occur on the surface of the iron range in thickness from one-sixteenth to three-sixteenths of an inch. These, we believe, are flow structures and represent the last physical change to take place on the iron during its flight. The deformed metal shows that a strong lateral force was exerted on the surface during its fall. After studying these zones of deformed metal, we found similar structures on other meteorites. The side of the iron

which has the best development of these features was, we suspect, the forward face during the last moments of high-velocity flight.

The cavities in this iron are a most conspicuous feature. Many of them are large, others are narrow but deep, and many have rims that curl inward. At one place a series of cavities makes a tunnel through the meteorite.

The irregular shape of the Goose Lake meteorite suggests that it probably did not hold a fixed position very long during its fall. Thus, if the cavities were made during its passage through our atmosphere, they formed in a fraction of the time the iron was in the atmosphere. The highest temperature and the major changes in shape occur on the front side of a meteorite, but it seems to us illogical to suppose that each of the cavities was made in the brief interval during which a fixed point was in front.

F. C. Leonard (1939a) and E. G. Linsley (1939a) each published a picture of the meteorite *in situ*, but as these pictures seem to be different, it is difficult to believe that both actually show the meteorite *in situ*. The side of the meteorite which was in front at the end of the flight may not be the side next to the ground, because the iron probably rolled after it struck.

Metallography and Chemical Composition

A large piece from the edge of the Goose Lake meteorite (pl. 2) was cut into slices, each about three-eighths of an inch thick. In these polished and etched sections it was possible to observe the distribution of the inclusions.

Schreibersite occurs in small elongated bodies, each surrounded by swathing kamacite. Troilite is less abundant and occurs in rounded inclusions, the largest measuring 1.75 cm. in diameter. Since many consecutive slices were available for examination, we are rather confident that no large troilites or long tubelike inclusions are present. A little schreibersite occurs between the troilite and the matrix, but this is a normal association.

The thin, dark oxide veins shown in plate 7 are essentially parallel to kamacite lamellae. The slice shown came from the edge of the meteorite, where the mass of metal is comparatively thin and where the metal was under the greatest strain during the fall. The strain exceeded the bond between the kamacite lamellae or between the kamacite and taenite, which explains why the oxide veins parallel the structures. Presumably the fractures were filled when the surface of the meteorite was extremely hot, because only then would the metal flow freely enough to enter the tiny cracks. The volume of injected metal is so small in comparison with the mass of the meteorite enclos-

ing these veins that no appreciable amount of heat was carried into the meteorite in this manner.

The plessite shown in plates 8 and 9 is unusual. The spheroidized inclusions suggest that it was heated long enough to form this structure and then cooled quickly. Such cooling is inconceivable while the mass was a part of some planetlike body. This structure could be developed by heat generated at the surface during the iron's flight; the only question is: Would there have been enough time?

The widths of the kamacite bands in the Goose Lake meteorite are within the range of those in the coarse octahedrite group, but the symmetrical pattern and uniform width of the lamellae make this iron resemble a medium octahedrite.

The average width of a series of kamacite lamellae in one slice is 1.61 mm.; in another slice, 1.51 mm. A few of these bands measured 5 cm. long, but the average is near 3 cm. The taenite is abundant, most of it darkened by reason of imperfect transformation and containing needles of kamacite. The plessite fields are numerous and varied in character.

In table 1 the composition of the Goose Lake meteorite is compared with that of seven other similar irons from widely scattered localities. Since the chemical analyses are nearly alike, these specimens should be compared with respect to other features. The Mbosi, Drum Mountains, and Goose Lake irons are large, each weighing over 1,000 pounds, but the other five meteorites are comparatively small. Unfortunately we have not seen all these meteorites, and the information concerning surface features was obtained from published descriptions. We have certain reservations regarding the data in the literature relating to the surface of meteorites, because the outside of these objects has not received much critical attention.

TABLE 1.—*The composition of the Goose Lake and other similar meteorites.*

	Goose Lake, California	*Aggie Creek, Alaska*	*Drum Mts., Utah*	*Mbosi, Tanganyika*	*Baquedano, Chile*	*Karee Kloof, South Africa*	*Lanton, Missouri*	*Moorumbunna, Australia*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Fe	90.80	90.89	90.70	90.45	90.90	90.79	90.40	89.53
Ni	8.39	8.54	8.59	8.69	8.82	8.27	8.33	8.82
Co	0.42	0.67	0.58	0.66	0.15	0.68	0.61	0.56
P	0.12	0.18	trace	0.11	0.24	0.24	0.18	0.29
S	0.00	0.00	0.00	0.01	0.05	0.00	—	0.02
Cu	n. d.	—	—	trace	0.03	0.03	—	0.07
Insol.	0.03	0.03	0.01	0.03	0.01	0.03	0.005	0.30
$\frac{Fe}{Ni+Co}$	10.91	10.42	10.47	10.23	10.68	10.76	10.64	10.08
Width of kamacite band in mm.	1.5	1–2	1	0.75	1.5–2.5	1–2	less than 1	0.5–1.5

The Aggie Creek, Alaska, iron (Henderson, 1949) weighed 43 kilograms but was described without seeing the main mass. The meteorite was recovered from placer gravels 12 feet deep; thus it was wet during most of the time it was in the gravels. The weathered surface of the piece that was available for study was free from corrosion pits.

Some of the cavities in the Drum Mountains, Utah, iron (Henderson and Perry, 1948a) may have existed before the meteorite entered our atmosphere. However, one cavity was nearly filled with iron rust when the meteorite arrived at the United States National Museum. The character of the iron oxide on the surface makes it possible to determine the orientation of the specimen in the field, and in this way we knew that the rust-filled cavity was inverted. Although it could not hold water, the moisture that condensed on its walls was trapped and thus evaporation was retarded. The oxide scales that almost filled the hole were so firmly embedded that they had to be chipped out even after the rough handling this 1,164-pound iron received between its fall and its arrival in the Museum. As it was shipped in an open crate, the freight handlers could see that it was almost indestructible, and it is unlikely that they handled it with care.

The Mbosi, Tanganyika, Africa, iron, according to Grantham and Oates (1931), "was buried two to three feet in a red loamy quartz rubble which was covered by a few inches of soil. The lie of the mass very similar to the hill. Scattered through the rubble, several feet from the mass, are scraps up to an inch and a half thick of black nickeliferous iron oxide. These, no doubt, are fragments of scales detached from the mass during its travel down hill."

Evidently corrosion removed considerable material, and the altered surface may have little or no resemblance to the preflight surface. Corrosion may have gone below the zone of cavities, as it did on the under side of the Canyon Diablo iron. The illustrations of the Mbosi iron show two or more depressions, but these could be the result of corrosion.

The 22-kilogram iron from Baquedano, Chile (Palache and Gonyer, 1932), was covered with pits. Its pitted surface was said to be "the effect of sand blasting." The authors stated that a portion of the surface was corroded, but the published illustrations showed no cavities similar to those in the Goose Lake meteorite.

The Karee Kloof, Cape Province, South Africa, meteorite (Prior, 1923) weighted 92 kilograms and showed "thumbmarks." The dimensions of one cavernous depression is given as 20 x 15 x 7½ centimeters. From a 7.1-gram sample Prior recovered some insoluble residue which had "the optical characters of quartz . . . ortho-

rhombic pyroxene . . . and some of feldspar having refraction slightly less than that of nitrobenzol (1.55) and showing in one case twin-striations with a low angle of extinction."

The finding of silicates in a meteorite exhibiting cavities could be a very significant observation for us. Unfortunately, one cannot be certain that Prior's sample was uncontaminated. It might help to explain the origin of cavities if silicates occurred in the irons that contain cavities, but we have no clear evidence that they do. If there were silicates, they should appear in the polished sections and not in the nonmagnetic portion of the insoluble residue. Usually some of the abrasive used during the preparation of the sample gets embedded in the softer minerals or cracks and then is recovered in the insoluble residue; we therefore discard the traces of nonmagnetic material that appear there.

The Lanton, Missouri, iron (Cullison and Muilenburg, 1934), weighing 13.7 kilograms, was in four pieces, all of them badly weathered. No cavities were mentioned, and apparently all the flight surfaces were corroded.

The Moorumbunna, Australia, iron (Edwards and Mawson, 1946) was said to have a pitted surface: "the entire surface is pitted, apparently the result of corrosion which must have continued over a long period of time. Pitting reaches a maximum depth of five centimeters below the main surface level; this indicates that the fall is by no means a recent occurrence."

Terminal Velocity

Many stony meteorites break up or explode after entering our atmosphere. Two or more pieces may fall simultaneously some distance apart and both be covered with fusion crust. When such pieces fit together, there can be no question that they came from the same object. The meteorites that separate into pieces probably do so when the velocity is high, as indicated by the fact that the fractured surfaces are covered with a fused crust. If the pieces fit together, we know that little material was lost from either portion. Stony meteorites are not as tough as the irons, and it is therefore easy to understand their breaking apart, but on the other hand some irons do the same thing. There are no statistics about the breaking of meteorites into pieces that will fit together again, but indications are that there may be nearly as many irons that do this as there are stones.

The Maldyak, Siberia, iron (Zavaritzkit and Kvasha, 1952) was split almost in half, and the illustrations show that one part apparently suffered more ablation than the other. An equally good example of the breaking up of an iron meteorite is the Boguslavka, Siberia,

specimen which fell Oct. 18, 1916 (Zavaritzkit and Kvasha, 1952). The Maldyak iron is an octahedrite; the Boguslavka iron a hexahedrite. It is much easier to explain the Boguslavka meteorite separating into fragments than the Maldyak iron, because hexahedrites have a cubical cleavage while the octahedrites have no cleavage.

Figure 1,*a*, taken from Zavaritzkit and Kvasha (1952), shows that the place of separation for these two pieces of the Boguslavka iron is at right angles to the base. The right side of the upper portion of the left piece is essentially parallel to the fracture separating the two pieces. Since these faces appear to be straight, flat, and normal to each other, possibly they are cubical cleavages.

Figure 1,*b*, was taken from Akulov and Brukhatov (1941) and is slightly different. The figure shows the reverse side of the Boguslavka iron, and the bottom of the front face of the smaller portion is unlike the view Zavaritzkit and Kvasha used. However, the right side of the smaller piece is essentially parallel with the adjacent side of the larger portion, again indicating cleavage. Neglecting the minor

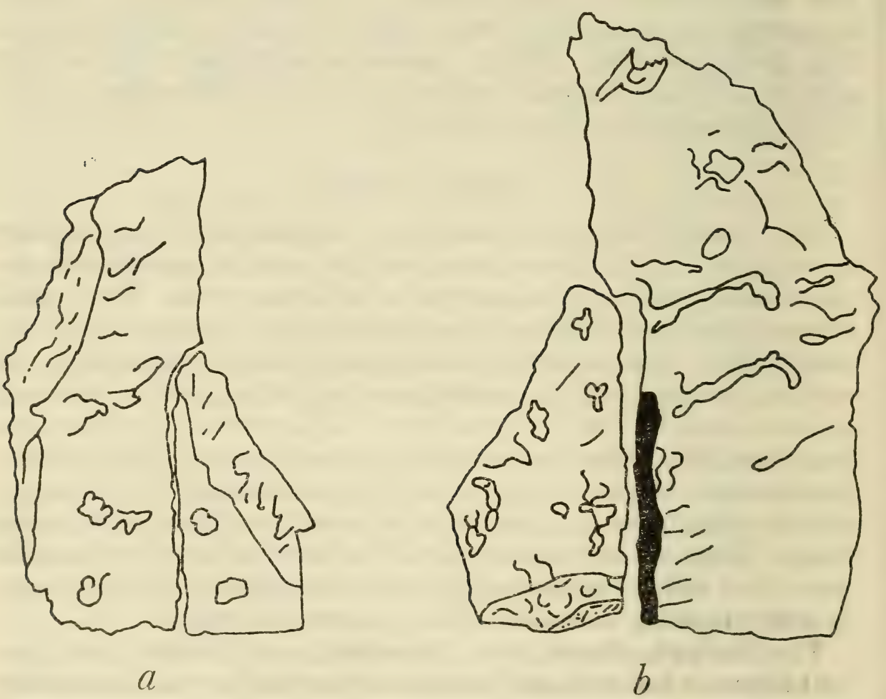


FIGURE 1.—Sketches of the Boguslavka meteorite, which possibly broke along its cubical cleavage directions. *a*, From Zavaritzkit and Kvasha (1952); *b*, from Akulov and Brukhatov (1941).

differences in the two views, it seems that this iron separated along cleavage directions during its high-velocity flight.

Meteoritic iron can be easily deformed by a light tap of a hammer. Since the Goose Lake iron was found on solid rock, has flight markings, and lacks impact scars, either its terminal velocity was low or something cushioned its fall. J. J. Cornish,[2] after a brief inspection of the specimen, stated that possibly considerable aerodynamic lift was given the meteorite during its fall because of its physical form. He said: "The large cavity [see pl. 1], which makes an opening to the tunnel through this iron, probably would give this body considerable spin during its fall. This spin could generate enough lift to reduce the velocity of fall." Independently, Cornish selected the same side of this iron that we did as the forward face during the fall.

The area in which the iron fell is covered during the winter months with deep snow which would break the impact with the ground. But if it fell on a layer of snow, how can we account for the depression that Leonard (1940) reported? Leonard mentioned an elliptical ridge measuring 24 feet east and west and 20 feet north and south and said the meteorite was located in a saucerlike depression approximately 5 feet in diameter. He apparently assumed that this was the place where the iron struck the earth.

Linsley (1939b) doubts that the saucerlike depression is significant and says, "there was only the slight depression in which it rested which appeared to be due in part to wind erosion as the air currents eddied about it."

Although one can only speculate about the terminal velocity of the Goose Lake iron, we are certain that it had a spectacular fall. The varied cavities must have produced some weird sounds as the air rushed past these openings. It is unfortunate that the iron landed in a sparsely settled area, because if it had come to earth in a more thickly populated region the terrified citizenry would surely have recorded the date and hour of the fall of this screaming meteorite.

Cavities

Cavities occur in many iron meteorities, but it need not be assumed that all cavities have the same origin. Some definitely are the result of terrestrial corrosion, but we are convinced that the cavities in the Goose Lake iron did not originate in that way. As we became more familiar with these features and discussed them with others, we came to feel that their significance was not appreciated and that the old explanations for cavities were unsatisfactory. Their physical features, significance, and some theories of their origin, as well as the origin

[2] Of the Engineering and Industrial Research Station, State College, Miss. Personal communications.

of the wide, shallow depressions known as "thumbmarks," are discussed in the sections that follow.

It is difficult to describe, measure, or photograph a cavity so that a reader can obtain a comprehensive conception of it, which may partially explain why these features have been neglected in descriptions of meteorites. The measurements recorded for these cavities are approximate values but are sufficiently accurate to give an idea of their size. We have determined the volume of a few cavities.

The cavities in some meteorites are bowl-shaped, but when a cavity is two to four times as deep as it is wide, it resembles rather a drill hole. However, cavities have one almost universal characteristic: The width of the opening at the surface is less than the diameter of the cavity measured down in the hole.

A rim of deformed metal overhangs and bends into many cavities on the Goose Lake iron. If the fingers are rubbed over the rim inward toward the cavity, the surface feels smooth, but when the direction is reversed the rim feels jagged. We believe the rim of overhanging metal was produced by thermal action on the surface of the meteorite after the cavity was there.

The largest cavity in this iron, shown in plate 1, has an irregular opening measuring approximately 10 by 12 inches. Within it there are 8 smaller cavities with openings measuring 0.5 to 2.0 inches in width and 0.5 to 1.0 inch in depth. An interesting feature of this large cavity is an opening in its base approximately 2 by 4 inches that leads into an oval cavity entirely within the meteorite. The oval cavity is approximately 7 inches long and 4 inches wide and has an opening on the rear face of the meteorite. The side wall of this cavity at one place is only about an inch below the surface. This place can be located in plate 1 between the middle of the long rule and the lower part of the opening to the large cavity directly above.

The oval chamber makes a tunnel through the meteorite. But since concealed cavities have not been found in any of the sections cut through iron meteorites, we do not believe that this oval chamber was a concealed cavity. The lip around the larger cavity (pl. 1) turns inward as does the lip around the opening from the bottom of the large depression into the tunnel. We regard this tunnel to be as much a primary feature as the hole through the Tucson, Ariz. (Ring), meteorite shown in pictures by Merril (1929).

It is impracticable to measure or illustrate in detail all the cavities; therefore, a few of the important types were selected for a more detailed study. With the assistance of W. E. Salter of the United States Geological Survey, latex molds of these cavities were prepared and plaster casts made of the molds. After a plaster mold was avail-

able, we investigated methods of measuring the volumes. By the method finally used, it is now possible to measure the volume of cavities in some large meteorites too heavy to be reorientated so that the cavities would be in position to be filled with either a liquid or sand.

After trying various methods, we found that "Climax" wallpaper cleaner (Simmons, 1942) could be successfully used to measure cavity volume. A film of oil was first applied to the walls of the cavity, then the opening was filled by inserting small wads of cleaner from a weighed amount. Each time the cleaner was added, it was pressed down with all the force that could be exerted with the fingers. After the hole was filled to the original surface of the meteorite, the weight of the excess cleaner was subtracted from the original weight. The density of the cleaner was obtained by packing it into various combinations of plumbing connections, such as elbows and tees. These simulated the cavities in the meteorite very nicely because certain combinations gave a sizable cavity with a small opening. After these were filled with cleaner, the material was removed and weighed, and the volume was then measured with water. As the cleaner absorbs oil from the walls of the cavity, its density varies and should be checked after several measurements. After a little practice we were able to determine the volumes of the cavities with sufficient accuracy for our needs.

TABLE 2.—*Measurements of a few cavities in the Goose Lake meteorite*

Depth (cm.)	*Width (cm.)*	*Width/depth ratio*	*Volume (cc.)*	*Estimated weight of Ni-Fe needed to fill cavity (gm.)*
10	11	1. 10	686	5451. 5
11	7	0. 63	340	2657. 0
8	2	0. 25	60	468. 0
11	5	0. 45	215	1677. 0

Many mineralogists believe that the cavities in iron meteorites were formed during flight when some included mineral burned out. The largest inclusions usually found in iron meteorites are troilite and schreibersite, with occasionally a carbon nodule, although generally the carbon is concentrated around the troilite. Usually the troilite and carbon inclusions are rounded masses with a diameter of less than 1 inch, whereas the schreibersite ordinarily is more elongated and irregular. The schreibersite is more uniformly dispersed in this iron than is troilite. In the slices so far cut from the Goose Lake iron, no single inclusion or aggregate occurs that approaches the dimensions of the cavities.

As troilite and schreibersite melt at approximately 1000° C. and are brittle, it is possible that they would be easily ablated by the air stream. If these minerals melted out to form a deep, narrow cavity, considerable iron around the inclusion must also have been removed, because, as stated above, the cavities in this iron are much larger than any of the inclusions thus far found. It is difficult to understand how a cavity 8 cm. deep with an opening of 2 cm. could be formed by melting out some included mineral, and possibly an equal volume of Ni-Fe alloy around the inclusion, without widening the opening to the surface. If the air within the tube is somewhat stabilized, it would retard the flow of heat toward the bottom of the hole, since air is an insulating medium.

Sections cut through some iron meteorites show cavities in which troilite still occurs at the bottom. If such cavities were formed by burning out the sulfide, it seems unlikely that troilite would be found in the bottom of some cavities. Its occurrence there may indicate that troilite is not as easily removed during the fall as has been assumed by some workers in this field.

As stated above, there are no inclusions in any of the sections of the Goose Lake, Canyon Diablo, or Willamette meteorites that even approach the dimensions of the cavities. This would seem to rule out the theory that the large cavities on the surface of these irons were formed by the burning out of troilite, schreibersite, or carbon inclusions except for one possibility. Perhaps the zone around the outside of these irons contained larger included masses of these minerals than now occur in these meteorities; consequently, size alone might not eliminate the burning-out theory. This possibility would introduce a new concept of iron meteorites, for in the past it has been tacitly accepted that the portion removed from the surface of a meteorite during flight had a composition and structure similar to that in the mass that fell.

Those who claim that the cavities were formed by the burning out of inclusions must account for the formation of large cavities at very high altitudes. Such cavities would have to be formed in a fraction of the time it takes the meteorite to pass through the atmosphere. The meteorite must pass part way through the rarefied upper atmosphere before collision with the air can have much effect on the surface. Toward the end of the flight, the velocity is so retarded that no changes take place on the surface. When these two time intervals are subtracted from the number of seconds required for a meteorite to fall through our atmosphere, we do not believe that enough time remains for a tumbling iron to undergo sufficient heat penetration to form the deep cavities on all sides.

The greatest changes that take place on a falling meteorite occur during the period of their maximum deceleration, which is but a fraction of the atmospheric passage. The size and shape of a meteorite affect the velocity it will retain during the fall. The Goose Lake meteorite has a rather wide cross section and therefore was probably decelerated rapidly. There is evidence that less heat was applied to the surface of the Goose Lake meteorite than to the surface of certain other meteorites. For example, there are no delicate stringlike markings of fused metal flowing away from the front face, and the cross sections through this iron fail to show any appreciable evidence of heat penetration, as the internal pattern of the metal continues to the edge without loss of detail. The failure to find a zone of modified structure near the edge of the Goose Lake iron supports our contention that these cavities were not burned out during flight.

If the Goose Lake iron entered our atmosphere with a high velocity, one would expect its surface to show some features similar to those found on the Freda, North Dakota (Henderson and Perry, 1942a), and the Pima County, Arizona (Henderson and S. H. Perry, 1949), irons. The external forms of these two meteorites indicate that more heat was applied to them than to the Goose Lake iron. There is no evidence that heat penetrated the Goose Lake iron as it did the Reed City, Michigan (Henderson and Perry, 1942b), the Bruno, Saskatchewan (Nininger, 1936), or the Murnpeowie, Australia (Spencer, 1935), meteorites.

The highest temperature on a falling meteorite occurs on the front face, while the thermal action on the rear surface is much less severe. A shock wave follows the outline of the front face, and the molecules of air which strike the iron pass through this wave and are compressed into the lateral flow moving toward the edges of the body. It is this lateral flow which ablates the iron. The hot gas that is compressed against the iron moves with a high velocity and is the agency that cuts obliquely across the cavities in the Canyon Diablo iron. It partially removed the cavities on the conical sides of the Willamette iron.

The temperature within a hole may be different from that which exists on the surface of the meteorite, and we are not sure that it would be below the temperature on the exposed surface. It can be argued that the temperature within a hole would be lower because air is a poor conductor and because the walls of the cavity would absorb heat.

It is possible also to argue in the opposite direction. Heat is lost from the outside surface by radiation, but the heat within the cavity cannot escape that way. Thus, if energy can be supplied through the opening in amounts which will produce an exothermic reaction,

possibly a higher temperature could exist within the cavity than on the outside surface. Furthermore, if an element in the included minerals could produce an exothermic reaction ,additional heat would be generated within the cavity.

The collision between the air molecules and the meteorite would ablate the surface, but the metal on the side walls ("bc" and "ef" of fig. 2) is both heated and ablated. As the lip of the cavity is ablated from two sides, the rim would recede faster than any other part.

A flow of considerable force exists on the front surface of a meteorite. This flow originates at the center and radiates in all directions from this point, producing the layers of displaced metal previously referred to as a type of flight marking. Thus, on the forward face of a falling meteorite we think that a depression should widen faster than it deepens. The diameter of an opening (fig. 2) should increase because the shaded areas are heat-softened from two sides. This perhaps explains why broad shallow depressions are more abundant than tubular cavities on iron meteorites.

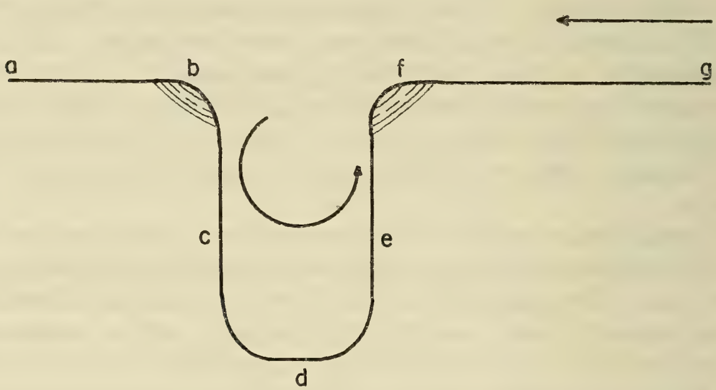


Figure 2.—Cross section of theoretical cavity in a meteorite, showing how the width of the opening increases faster then the depth. The shaded area probably would ablate faster than the outside surface of the meteorite between "a" and "b" as well as "f" and "g." The sides of the cavity, "c" and "e," may be ablated faster than the bottom, "d," because there should be a vortex established within the cavity. The arrow indicates the direction of the lateral flow, and the vortex within the cavity should rotate as the arrow indicates; thus, the sides "c" and "e" may be undercut.

The above explanation accounts for those shallow but wide depressions called "thumbmarks." Sometimes these "thumbmarks" are closely spaced on the surface but are separated by narrow ridges of metal. The fact that the separating ridges are irregular suggests that their position was constantly changing. A ridge has a large exposed surface compared to its volume; consequently the metal in it would be heat-softened to a point where it could be mechanically ablated more rapidly than the metal on a flat surface.

The surfaces of some meteorites pass obliquely across tubelike cavities leaving outlines of parts of these cavities still preserved. When a surface cuts obliquely across a cavity, the evidence indicates that the cavity was being modified at the surface rather than within the hole. It also means that the deep and narrow cavity existed when the meteorite had a high velocity. These oblique cuts provide a method of estimating the thickness of metal that was lost, although possibly they give a value closer to the minimum than the maximum.

Two Canyon Diablo irons in the U. S. National Museum have oblique cuts across cavities. Probably no specimen better shows how much metal was removed after the cavities existed than the Willamette, Oregon, iron. Pictures of the large cavities in the base of that conical mass are well known, but few observers have noted the remnants of cavities on the conical sides of the specimen. The conical-shaped meteorites are cited as having held a fixed position through most of their flight. If that is true, the shallow depressions on the conical surface of the Willamette iron are probably remnants of cavities similar in size and shape to those on the rear surface. The rear face of a meteorite undergoes little change during flight. Thus, the rear side of the Williamette iron, which exhibits deep craters, may have some topographic similarities to the surface that existed there before the iron entered our atmosphere.

Although this is not a discussion of the Willamette iron, it should be mentioned that the specimen needs to be restudied. It was described as a medium octahedrite and continues to be so listed, although none of the specimens we have seen contains a trace of the Widmanstatten structures; instead all have granulated structures. Possibly these pieces were heat-treated at the time they were removed from the main mass or afterward. If further study of the Willamette iron were to show that the heat penetrated deeply into the main mass, this might be an indication that the meteorite was heated before it entered our atmosphere.

Although the Social Circle, Georgia, iron (Henderson and Perry, 1951) has no cavities, it is a sizable iron and is granulated throughout. In this case the granulation apparently did exist before the specimen entered our atmosphere. Since the cavities in the Goose Lake meteorite are enclosed in metal with a normal Widmanstatten structure and since the etched structure extends to the edge of the slice, there is no evidence visible to the naked eye of thermal changes in the outside zone of this iron.

The velocity of all meteors entering our atmosphere is high enough so that sufficient heat is developed by the collision with the air to fuse the surface and change the shape. The Canyon Diablo individuals

mentioned above and the Willamette iron show a loss of metal after the formation of the cavities. There are no conspicuous oblique cuts across the cavities in the Goose Lake meteorite, which indicates that it traveled with less velocity through the air than either of the two above-mentioned meteorites.

The two large Canyon Diablo individuals have deep cavities on one side but no holes on the side that was next to the ground. The upper surface still shows some flight markings, indicating that almost no metal was lost since its fall. An examination of the under surface gives the impression that the specimens are very old, but an opposite opinion would be gained if only the exposed surface were examined.

It is reasonable to believe that there were cavities on all sides of these Canyon Diablo specimens when they entered our atmosphere, and we are certain that these cavities existed before the meteorite hit the earth. Since the fall, corrosion has removed enough iron from the under surface to obliterate the cavities. Just when the Canyon Diablo iron fell is unknown; it may have been 10,000 or even 50,000 years ago.

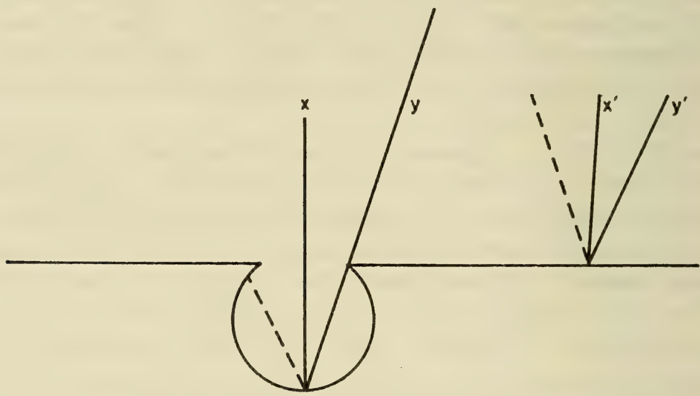


Figure 3.—Cross section of theoretical cavity in a meteorite, showing how its size may increase below the surface by the bombardment. Particles colliding along directions indicated by "x" and "x′" will rebound along the same direction, but those striking parallel to "y" and "y′" will rebound in a different direction. Since most of the particles falling within the cavity will rebound against the side walls, this action may produce the undercutting.

But the difference between the corroded under surface and the top of the specimen shows how slow atmospheric corrosion is compared to the corrosion that takes place on the under side.

The lateral flow over the forward side produces the overhanging rim of metal on one side of a cavity, but there is no satisfactory explanation for an overhanging rim of metal entirely surrounding the cavity. If the moving air pushes metal into the cavity, we are unable

to understand why the air which has to escape will not bend some metal the other way.

Although it is our belief that the shape of these cavities and their overhanging rims of metal point to the existence of the cavities before the meteorite entered our atmosphere, R. N. Thomas [3] has a different and interesting explanation for the shape of the cavities. He considers that if a hole existed, it acted as an energy trap (fig. 3). The particles that collided with the outside of the meteorite were reflected away, while those that hit within the cavity were reflected against the side walls; this bombardment undercut the sides.

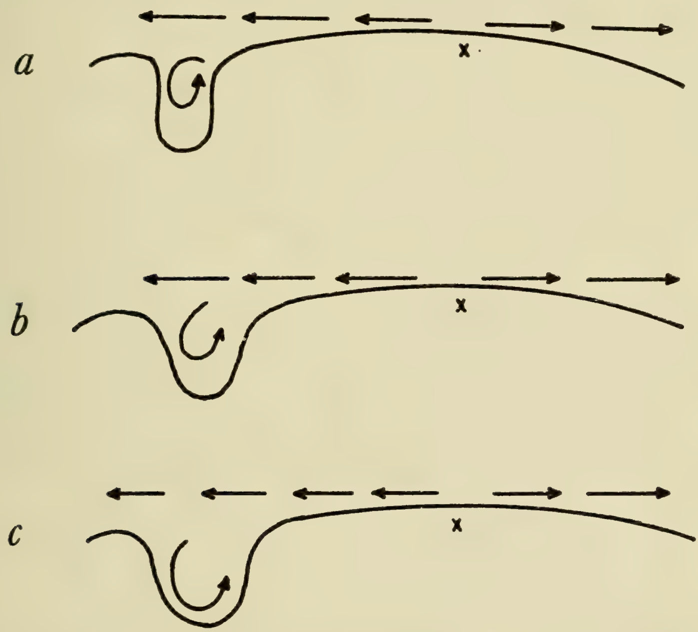
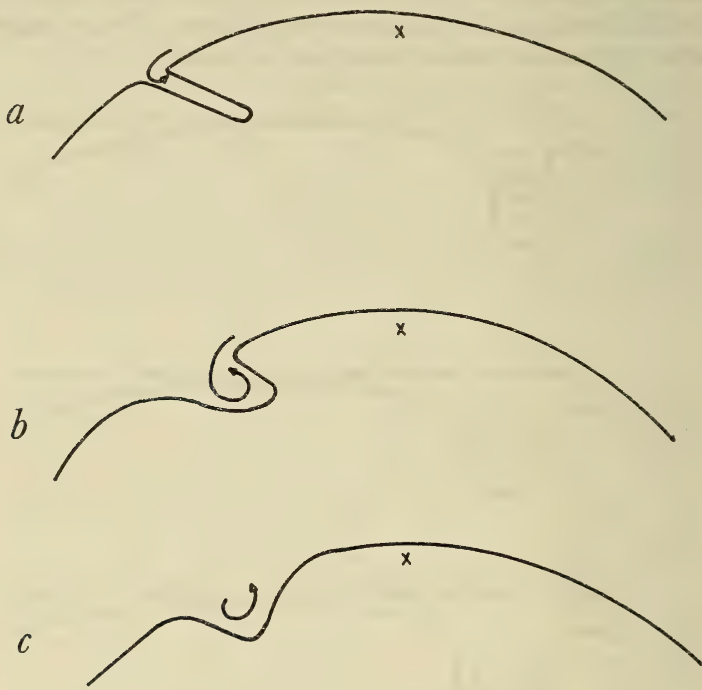


FIGURE 4.—Cross sections of theoretical cavity in a meteorite representing the progressive changes (*a*, *b*, *c*) when the long axis lies parallel to the direction in which the mass is falling. The stagnation point is indicated by the "x." The small arrows indicate the direction of the lateral flow. The ablation, at the opening to the cavity, is greater on the side towards which the flow is directed.

A bombardment such as Thomas suggests probably does occur, but we believe that the lateral flow of hot air on the front of the meteorite is the predominating force. The progressive changes shown in figure 4 illustrate our conception of what happens to a deep but narrow cavity, essentially normal to the lateral flow, which holds a fixed position on the front of a falling iron. Since the air flow originates at the center of the front face, the stagnation point, and moves

[3] Personal communications.

in all directions, the cavity rim farthest away from the stagnation point would get the direct impact of the lateral flow. The metal in the rim would be heated from the top and from within the cavity, with the result that the rim would be ablated much faster than the surface of the meteorite. It seems clear that this blast of hot air would widen the opening of the hole faster than the general surface of the meteorite would recede and faster than the cavity would be deepened.



a
b
c

Figure 5.—Cross sections of theoretical cavity in a meteorite representing the progressive changes when the long axis is oblique to the direction in which the mass is falling. Similar conditions exist here as in figure 4 except for the incline of the long axis. The thin, overhanging lip would be ablated more rapidly than the opposite side. The stagnation point is indicated by the "x."

Although ablation is probably greatest on the rim farthest from the stagnation point, the opposite rim is also heat-softened and ablated. The lateral current of air blowing across the opening of the cavity would establish an eddy in the mouth of the hole. This eddy would direct hot gas against the inside wall for a distance down in the cavity about equal to the diameter of the opening. The turbulent gas must contain solid particles torn from the surface of the meteorite, and these particles should ablate the metal on the side walls as fast as heat

softens it. Almost simultaneously this lateral flow of hot-air heat would soften and ablate the rim around the cavity with the result, we believe, that the cavity would be widened faster than it is deepened.

When the long axis of the cavity makes an acute angle with the plane of the lateral flow (fig. 5), the side nearest the stagnation point, or the upstream rim, would be widened more rapidly than the opposite side. In this case, the eddy established in the cavity opening would direct heated air against the inside wall on the upper side of the opening. As the overhanging metal is thin, it would be softened and more quickly ablated than the lower side. This process could change such a cavity into something like that which exists on the Canyon Diablo meteorite (see p. 351), or, if there is enough time, the lateral flow could make a wide and shallow depression, or "thumbmark."

Were cavities formed by shrinkage?—H. C. Urey and G. P. Kuiper [4] independently suggested that cavities in iron meteorities might be due to shrinkage when the metal solidified. Although depressions occur in cast metals, there are so many differences between the shape and location of cavities in ingots and in meteorites that this hypothesis seems very unlikely.

A liquid conforms to the shape of its container, so that only its upper surface is free. Thus the cavities in ingots occur in the upper part or close to the upper surface. This point was comprehensively discussed by Camp and Francis (1951), and their illustration indicates that the cavities in ingots usually resemble inverted cones. In all but a "killed ingot" the conspicuous shrinkage features and cavities occur in the core of the upper part. "Killed ingots" cool rapidly, and inasmuch as such cooling has no place in the history of meteoritic iron we believe that the features of such ingots need not be discussed.

Were cavities formed by gas or liquids?—The metallic portion of a meteorite solidifies at a lower temperature than the silicates. If gas or liquid phases are given off as a metallic portion solidifies, these would escape through the enclosing silicates as long as they remained porous. When the mobile phases can no longer escape and as they do not combine with the metallic or silicate constituents, they must accumulate somewhere. The most likely place would be between a large iron mass and the enclosing zone of silicates. Thus, possibly these mobile phases accumulated near the outside edges of the large metallic masses.

The occurrence of metallic phases in stony meteorites indicates that the metal was injected after the silicates were formed and in the position they now occupy.

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[4] Personal communications.

In iron meteorites, usually some schreibersite occurs around the troilite inclusions. It seems reasonable to assume, therefore, that around a large concentration of metallic iron in a silicate body, a swathing zone of some type existed which now is completely gone. Such an enclosing zone could be rich in chlorides, sulfides, phosphides, etc. Such phases may have filled the embayments or cavities in the iron and through some unknown process subsequently vanished. Although at the present time this is pure speculation, there is a reasonable possibility that such a zone existed.

Nash and Baxter (1947) studied the gas within six meteorites and found that four of them contained less than 10 cubic millimeters of total gas under normal temperature and pressure per gram of meteorite. The Canyon Diablo iron had much more gas than the average of the six meteorites they studied, and it may be significant that the Canyon Diablo individuals contain cavitites.

If Baxter's values for the Canyon Diablo iron are taken for the Goose Lake meteorite, there would be about 35.01 cubic meters of gas (N.T.P.) within the latter.

$$\frac{30 \text{ cu. mm. x } 2573 \text{ lbs. x } 453.59 \text{ gm. per lb.} = 35.01 \text{ cu. m.}}{10^{6}}$$

An ultraconservative estimate of the liberated gas would be between 5 and 10 times the amount of residual gas in a meteorite; for the Goose Lake iron, this would give between 175 and 350 cubic meters of liberated gas under N.T.P. Considering the pressure and temperature the gas would be under when the cavities formed, probably there was enough liberated gas to fill these cavities.

When iron is cast it conforms to the enclosing mold, so that the gas cavities or shrinkage features develop only on the upper surface, whereas in the Goose Lake meteorite there are cavites on all sides. Ingots are, of course, made in the earth's gravitational field, but possibly meteoritic iron formed in a gravitational field which was not as strong as that of the earth, and therefore cavities might occur around the entire mass.

Were cavities formed by weathering?—The corroded surface of a buried iron meteorite differs from a weathered exposed surface. The pitting on the buried side is usually wide and shallow, and the metal ridges separating corrosion pits are generally sharp. Furthermore, the iron oxide on the buried surface is rough and usually thicker than that on an exposed surface. Corrosion acts on the side of the iron next to the ground, or all over a buried iron meteorite, much faster than it does on the upper exposed surfaces.

Many arguments can be marshalled against the formation of cavities in the Goose Lake meteorite by weathering. The cavities occur on

all sides of the specimen instead of chiefly on the side next to the ground where corrosion would be expected to be the greatest. Corrosion on an exposed surface is slow, and during the great length of time that would have been required to weather out such deep holes on exposed surfaces of the meteorite, the surface next to the ground would surely have developed the characteristic corrosion pattern of the under side of a metorite; this it did not do.

If the cavities in the Goose Lake iron were made by weathering, those in the upper side would have been full of oxide when the specimen was found. We know, however, that the cavities were free from oxide because many trained observers were present when the iron was relocated and their published accounts contain no mention of rust filling any holes. The field notes that the observers published contained descriptions of the size and shape of the meteorite, its cavities, nature of the terrain, the depression around the iron, the altitude and slope of the ground where the specimen was found, but not a word about rust in the cavities. Surely these men would have mentioned rust if it were abundant in the cavities or if it were found on the ground near the meteorite.

Linsley (1939a) wrote:

> The side which rested on and was partly in the soil has the characteristic appearance of rusty iron, but is smooth and nowhere crumbling in disintegration. The prominent external pits characteristic of iron meteorites were far less numerous on this protected side. On the exposed side the external pittings had developed into holes, many of which were several inches deep; some extending through the specimen. There were no sharp edges or angles on the meteorite. There was no accumulation of rusty pieces on the ground around it.

Deep holes such as those occurring in this meteorite are less common on other irons than the shallow, wide depressions or "thumbmarks." However, on the Goose Lake iron there are more deep holes than "thumbmarks." We disagree with Linsley's observation about the exposed pits developing by weathering, and we do not see any conspicuous "thumbmarks." Furthermore, no surface of this iron indicates prolonged weathering, and the flight markings on the sides exhibiting the deep holes make it seem extremely unlikely that weathering produced these cavities.

One surface of each of the two large Canyon Diablo specimens in the National Museum is deeply corroded, with considerable metal removed. This is the part that was either buried or next to the ground. The oxide on that side is thick, rough, and different in appearance from that which occurs on the exposed side. Yet the Canyon Diablo irons, like the Goose Lake iron, show flight markings on the side with the cavities. We regard this as a significant fact,

because the flight markings were made after the cavities. The surface of a meteorite that is exposed to the air apparently is extremely inert compared to the side next to the earth.

Everyone who has examined the Goose Lake iron with us agrees that no side shows extensive corrosion. It has the appearance of being a recent fall, although we have no definite evidence that it is. It is definitely not an old fall.

Are the cavities impact scars?—If a small meteorite collided with a large iron, we believe that the impact would make a craterlike scar. The material composing the small meteorite is not as important as the velocity with which the two bodies collide. If the large mass were iron, the impact shock would be absorbed without fracture, as meteoritic iron is malleable. We suspect that the impact scar the small body would make on the larger mass would resemble the meteor craters on this earth, because both are produced by a small body with high velocity striking a larger mass.

Most meteor craters are bowl-shaped and have upturned rims around their edges. The diameter across the opening is greater than that below the opening. The ratio between the width and depth of terrestrial meteor craters and the cavities in the Goose Lake iron are different (see table 3). Probably the shape of the terrestrial meteor craters has been modified by weathering, and possibly to some extent so have the holes in this iron. The difference in shape between the meteor craters and the cavities in the Goose Lake meteorite becomes conspicuous when the width/depth ratios are compared.

TABLE 3.—*Comparison of terrestrial meteor craters with four typical cavities in the Goose Lake iron*

Crater	*Width (in feet)*	*Depth (in feet)*	*Width/Depth ratio*
Canyon Diablo, Arizona	3, 900	570	6. 8
Wolf Creek, Australia	2, 800	170	16. 5
Boxhole, Australia	575	52	11. 1
Odessa, Texas	530	18	29. 4
Henbury, Australia	360	60	6. 0
Henbury, Australia	240	25	9. 6
Henbury, Australia	30	3	10. 0
Warbar, Arabia	328	40	8. 0
Goose Lake cavities	*(in cm.)*	*(in cm.)*	
1	11	10	1. 1
2	7	11	0. 63
3	2	8	0. 25
4	5	11	0. 45

Since a small meteorite striking a larger one would penetrate the large body and possibly volatilize, there might be nothing left to be identified. It is likely that the impact would not disturb the structure of the Ni-Fe alloy in the large body very far beyond the limits of the crater, but we are not certain of this point.

Wave action within a cavity.—If cavities existed in an iron before it entered our atmosphere or if they formed quickly after the iron entered, we must not neglect the changes that wave action would make within a hole. The lateral flow of heated air over the forward side would pass over the opening to the hole, inducing wave action. The crests of these waves would strike the sides and be reflected back from the bottom of the cavity.

Solid particles ablated from the surface would get into the cavity and be hurled against the side walls and bottom. More work would be done on the side walls than on the bottom. Possibly the ablation on the walls would exceed that on the exposed surface of the meteorite. The reasons for this could be: (1) The heat might be higher within the cavity than on the exposed surface; (2) the side walls would be both heated and to some degree ablated with a bombardment of heated particles; and (3) perhaps the frequency of impacts against the side walls would be greater than the collisions on the surface of the iron.

The wave action within a cavity during the fall of a meteorite is complex, and our limitations prevent us from fully analyzing the reactions. However, we believe that the most violent action would occur just inside the opening, and if this is true, the tendency would be to widen the opening faster than the cavity is deepened.

Are the cavities primary structures?—Since we seem to have no satisfactory explanation for the formation of a cavity in an iron meteorite during its fall, the possibility must be considered that cavities existed before the meteorite entered the atmosphere.

More metal is ablated from the forward side of a falling meteorite than from any other surface. But on a tumbling body no surface receives the extensive ablation that the front side does when the mass holds a fixed position. The Goose Lake iron has no truncated cavities and no zone of granulated metal along any of its edges. These facts, together with the features previously discussed, to us constitute evidence that this iron fell with a lower velocity than many of the other meteorites.

We believe that the surfaces of the Canyon Diablo specimens discussed previously were ablated after the cavities were made. Their shape and the fact that several of their cavities are truncated by the surface, exposing 2 inches of a tubelike depression on the down-slope

side, indicate that these holes already existed when the outside surface was being ablated.

It is unrealistic to assume that the cavities in the Canyon Diablo irons were much deeper than the combined length of the trough and the depth of the present holes. If it is assumed that these holes were 4 inches deeper than they are now, the cavities would have been about 6 to 10 inches deep and possibly less than an inch wide. A hole of such dimensions would seem most improbable.

If 2 to 4 inches were lost from one side of the meteorite, the diameter of the meteorite would have decreased 4 to 8 inches. If that much metal were ablated from an iron such as the Goose Lake specimen, the percentage of weight lost would be large. But if our assumption of the metal lost by ablation is high—and it probably is—the dimensions of the meteorite would not have been greatly reduced in flight, in which case the present mass may still have some of its primary cavities.

Cavities, as far as we know, do not occur within iron meteorites. If these are preflight features, it means that no sizable piece was broken from the Goose Lake iron during its fall through our atmosphere. Also, it is unlikely that this meteorite came from the metallic core of some planet, for if it had, the implication would be that cavities existed there, and such a condition seems improbable.

It might be suggested that these cavities were filled with some mineral which has since vanished, but it is generally assumed that meteorites rather reliably represent the body in which they formed and also that the composition and structure of the portion that was lost in flight are essentially the same as those of the mass still remaining. There is no evidence that any low density minerals were concentrated near the outside edges of the larger meteorites.

The metallography of the metal in the overturned rims of cavities needs further study. In a section cut through the rim of a cavity in the Goose Lake iron (pl. 6), the Widmanstatten pattern was neither obliterated nor granulated. Granulated zones have been found around the outside edges of several iron meteorites, and those zones are usually wider than the overhanging lips of metal around the cavities. In general there is little evidence that heat penetrated the Goose Lake meteorite; the limited evidence found is discussed in the section dealing with the metallography. However, the feature which did indicate a thermal change was found near the surface of this iron.

After reviewing all the evidence or possibilities outlined in this paper relative to the origin of cavities, we are inclined toward the view that the deep, narrow holes in the Goose Lake iron existed before it entered our atmosphere. The specific manner in which they were

formed is not understood, but our basic reasons for thinking that they are preflight may be summarized as follows:

The most common flight markings on iron meteorites are the broad, shallow depressions called "thumbmarks" which definitely originated during the fall through the atmosphere. The Goose Lake meteorite has many more deep, narrow cavities and fewer "thumbmarks" and threadlike flight markings on its surface than most iron meteorites. The fact that this iron lacks the surface features which suggest a high velocity of fall favors the preatmospheric origin for its cavities.

No evidence was found that heat penetrated this specimen to any appreciable depth. The depth of the cavities, their peculiar shape, and the overturned rims around them cannot be explained by the thermal penetration we observed, by the original shrinkage of the metal, or by terrestrial weathering. The possibility that cavities represent something that was burned out during the flight through our atmosphere seems most unlikely because in the many sections cut through this iron, no inclusions were found that even approached the dimensions of the cavities. Furthermore, the length of time this iron was in flight through the atmosphere seems insufficient for enough heat to penetrate to the depth of the cavities and melt the quantities of metal that might have filled them.

Cavities are narrower at the openings than within; if they were made by air streaming over the surface of a meteorite during its flight, surely the openings would be widened faster than the cavity was deepened. Finally, if cavities like these originated during the flight in our atmosphere, it seems strange that they occur in only a small percentage of the known iron meteorites.

Summary

A 2,573-pound iron meteorite from Goose Lake, Modoc County, Calif., found in 1938, is described, and a general discussion of the cavities in iron meteorites is presented. The chemistry, metallography, and physical features of this and seven other meteorites from widely scattered places are given. The cavities in this iron, a conspicuous feature, are discussed, and reasons are stated why they are believed to be primary features. The cavities are compared with those in other meteorites. A study of the cavities indicates: (1) That this meteorite is not much smaller now than when it formed in some primordial body; (2) that no large piece broke off during flight; and (3) that this probably is not a portion of the metallic core of the planetlike body where it was formed.

The origin of cavities is a complex subject, and only the general theories of their formation are here outlined. It is our hope that this

generalized discussion will stimulate further investigations of cavities in iron meteorites. Although we believe that the cavities in this meteorite existed before it entered our atmosphere, we do not infer that all meteoritic cavities are preflight.

The Cincinnati, Ohio, Meteorite

Plates 10, 12

This iron meteorite was said to have been found near a dwelling in Cincinnati, Ohio, and was classified as a nickel-poor ataxite. It was first mentioned by Wulfing in 1897, and later by Cohen in 1898 and 1905; a summary of the former descriptions was published by Farrington in 1915.

When Perry in 1944 studied this specimen, which was obtained from the American Museum of Natural History, he observed numerous inclusions and identified them as phosphide bodies. Most of these small inclusions were rounded and gave the appearance of having been diffused by preterrestrial reheating. Since these particles were abundant, we suspected that there was more phosphorus in this iron than was shown in the analysis. Because of this and of the possibility that other chemical determinations might be unreliable, a restudy of the meteorite was made.

A 16.33-gram slice was removed from the sample lent by the American Museum of Natural History and was dissolved in HCl (1 part HCl, 2 parts H_2O). The gas given off was passed through a solution of lead acetate. The lead sulfide was recovered, converted into lead sulfate, and calculated to sulfur. The residue, which weighed 0.0067 gram, was so small that it was impossible to make an analysis, but chemical tests proved that this residue was rhabdite.

Table 4.—*Chemical composition of the Cincinnati, Ohio, meteorite*

	1	2
	Sjostrom (*in Cohen*, 1898)	*New analysis*
Fe	94. 47	94. 12
Ni	5. 43	5. 33
Co	0. 68	0. 74
Cu	0. 01	n. d.
P	0. 05	0. 19
S	0. 05	0. 006
Rhabdite	—	0. 05
Total	100. 69	100. 436
Density	7. 68	7. 71
Mol. ratio $\frac{Fe}{Ni+Co}$	16. 41	16. 51

The agreement between the densities of the two samples indicates that the sample we restudied was similar to the one Sjostrom had. However, these densities are low for meteoritic iron. The pieces restudied came from a small specimen that was somewhat altered, and it was therefore impossible to avoid including some altered material. There was not enough oxidization to make a significant difference in the analysis, but the included phosphide and the oxide reduced the density of the iron.

The main difference between these analyses is in the phosphorus content; the reanalysis has almost four times as much phosphorus as Sjostrom reported. The higher value is more consistent with the metallography shown in plate 12.

The amount of schreibersite or rhabdite in the analyzed sample may be calculated from the phosphorus reported. To simplify the calculation, the phosphorus content of the mineral was rounded off at 15 percent. Thus, the sample reported in analysis 2 contains 1.26 percent of phosphides by weight. For some reason most of the phosphide inclusions are soluble in dilute hydrochloric acid, which is contrary to the usual finding.

The photomicrographs of the Cincinnati iron (pl. 10) indicate that the rhabdite reacted with the matrix. This reaction, we believe, occurred subsequent to the original segregation of the rhabdite and either before the meteor entered our atmosphere or during its fall through the air. When the temperature of the mass was raised, the inclusions partly redissolved in the matrix. The cooling process which followed was so rapid that the material taken up from the matrix in the reheating process could not be rejected. We suspect that the reheating had something to do with making the phosphide soluble. Also, we found in other meteorites, where similar metallographic evidence of reheating occurs, that an appreciable amount of phosphorus dissolved in the same strength of acid.

Because many old analyses of iron meteorites are inaccurate, it is worthy of note when one which seemed to be incorrect was found to be good.

We express our appreciation to Dr. Frederick H. Pough, formerly of the American Museum of Natural History, for making this meteorite available for restudy.

Summary

A new analysis confirms the old analysis with the exception of the phosphorus determination. The phosphide mineral in the meteorite is largely soluble in acid. This iron apparently was reheated after it originally cooled.

The Pittsburgh, Pennsylvania, Meteorite

Plates 11, 13–15

This 292-pound iron was found in a field along Miller's Run, Allegheny County, Pa., in 1850. Shortly thereafter the main mass was carried to Pittsburgh and wrought into a bar; thus most of the meteorite was lost to science before it was studied. Since there are conflicting statements in the descriptions of this iron, a reinvestigation was desirable.

When the Pennsylvania meteorites are plotted on a map, the Pittsburgh, New Baltimore, Mount Joy, and Shrewsbury irons lie on a line starting near Pittsburgh and extending eastward for about 180 miles. Because of this alinement it might be suspected that the falls are related. Our reexamination of the Pittsburgh meteorite makes it possible to compare the four Pennsylvania irons and also one from Wooster, Ohio, lying on the same line but to the west of Pittsburgh.

The data on the Pittsburgh meteorite were summarized by Farrington (1915b) and by Stone (1932), and, since their publications are more readily accessible than the original descriptions, no references are made to the earlier work on this meteorite.

We were fortunate in having two specimens because they differ in some respects. The Yale sample is granulated, indicating that it had been reheated, whereas the Harvard sample apparently had undergone no thermal treatment.

The Pittsburgh meteorite has been classified as both a coarse octahedrite and a hexahedrite by Farrington (1915b), but it is definitely a coarse octahedrite. Most of its kamacite occurs in irregular masses, but one area in the Yale specimen shows a Widmanstatten structure (pl. 11, top). The Yale sample is granulated, so that the outline of many of its kamacite areas are not sharply defined; thus measurements of the widths of those bands are unsatisfactory. The average width for several of the lamellae in plate 11 is 2.08 millimeters. The orientation of the cut was not determined, but the lamellae are wide enough to place the Pittsburgh iron among the coarse octahedrites.

The irregular kamacite areas in the Harvard sample are partly bounded by taenite. Open fractures occur between some of these kamacite granules, but this is a common feature for coarse octahedrites. One small trigonal plessite area was found. The kamacite in the Harvard specimen shows three sets of Neumann lines, but none was found in the Yale sample. Possibly they were lost when the piece was heated.

Most of the kamacite areas in this meteorite are not enclosed by a continuous band of taenite. When the taenite thickens, its centers

consist of dark, untransformed alpha-gamma iron. Numerous rhabdite needles occur in some of the kamacite (pl. 13); cohenite inclusions were identified (pl. 15), and a few plessite areas were found (pls. 14, 15).

Since both the Harvard and Yale sections were small, neither contained much of the original crust of the meteorite; the small amount that remained was similar on both. The surface oxide and other features show clearly that the two samples came from the same meteorite.

Our analysis was made on a piece taken from the Yale specimen. The sample was dissolved in HCl (1 part HCl, 2 parts H_2O), and the magnetic part of the insoluble residue was retained in the flask by attaching a strong magnet to the bottom of the container while the solution was filtered to recover the carbon. By counting the grains in a portion of the magnetic residue, we estimated that there was about 10 percent cohenite and 90 percent rhabdite in the residue, and both minerals were later identified by X-ray.

TABLE 5.—*Chemical composition of the Pittsburgh meteorite*

	(1) *New analysis by E. P. Henderson*	(2) *Calculated composition after correcting for rhabdite and cohenite*	(3) *Genth's analysis (Farrington, 1915b)*	(4) *Hildebrand's analysis (Farrington, 1915b)*
Fe	[a] 91. 6	92. 15	92. 80	93. 38
Ni	6. 77	6. 99	4. 66	5. 89
Co	0. 66	0. 67	0. 39	1. 24
P	0. 12	0. 22	0. 25	0. 15
S	0. 018	0. 018	0. 03	0. 05
Cu	—	—	0. 03	0. 05
C	—	0. 001	—	—
Cr	—	—	—	0. 2
Mn	—	—	0. 14	—
Rhabdite, Cohenite	0. 76	—	—	—
	100. 00		98. 30	100. 80

[a] By difference.

As the residue contained rhabdite as well as a small amount of cohenite, and as some loss occurred during the picking operations, we decided to correct the figures for Fe, Ni, Co, and P for the quantities contained in the residue. The nickel content of rhabdite was arbitrarily set at 25 percent, the phosphorus at 15 percent, and the cobalt at 0.75 percent. The difference between the sum of these elements and 100 was taken to be iron. Incompleted studies by the authors show that cohenite has a fixed composition, with a carbon

content of approximately 6.5 percent; therefore, the iron it contains can be obtained by difference. Thus, if our estimates for the proportions of rhabdite and cohenite and the assumed compositions are about right, it is possible to correct the analysis in column 1 of table 5, for these two minerals. The adjusted analysis is given in column 2 of the table.

The specimen analyzed had a density of 7.89, which is low for a meteorite belonging to the coarsest octahedrite group (Henderson and Perry, 1954). But the sample selected contained traces of oxide and some included minerals, and it had been thermally treated, all of which reduce the density of meteoritic iron.

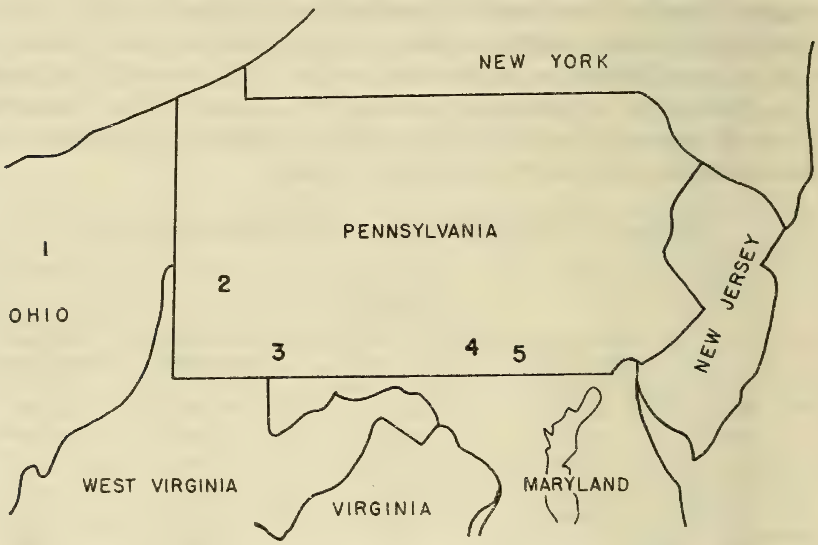

Figure 6.—Map showing the locations of the iron meteorites that have been found in eastern Ohio and in Pennsylvania. 1, Wooster, Wayne County, Ohio; 2, Pittsburgh, Allegheny County, Pa.; 3, New Baltimore, Somerset County, Pa.; 4, Mount Joy, Adams County, Pa.; 5, Shrewsbury, York County, Pa.

The five iron meteorites plotted in figure 6 were found almost on a straight line extending about 275 miles eastward from and slightly south of Wooster, Ohio. There are no historical records of the date of fall of any of these irons, but the pattern of distribution might suggest that all five represent a meteor shower. Their analyses are listed in table 6.

The Wooster, Ohio, meteorite apparently has not been reinvestigated since Smith (1864) described it. He gave the density of this iron as 7.901, and by calculating the density from the analysis we got 7.903. Such agreement indicates that the analysis is consistent with the density Smith reported; hence the analysis is essentially correct.

This reanalysis of the Pittsburgh iron, the reanalysis of the Mount Joy iron (Henderson, 1941), and the analyses of the New Baltimore (Merrill, 1923) and the Shrewsbury (Farrington, 1910) irons are all

Table 6.—*Chemical composition of the five meteorites located in figure* 6

	Wooster, Ohio	*Pittsburgh, Pa.*	*New Baltimore, Pa.*	*Mount Joy, Pa.*	*Shrewsbury, Pa.*
Fe	93. 61	92. 15	93. 25	92. 93	90. 84
Ni	6. 01	6. 99	6. 42	5. 76	8. 80
Co	0. 73	0. 67	0. 32	0. 61	trace
P	0. 13	0. 22	0. 037	—	0. 29
S	—	0. 018	—	—	0. 01
C	—	0. 001	0. 015	—	—
Si	—	—	0. 01	—	—

sufficiently different to make it certain that these are independent meteorites. Furthermore, when sections of the five irons are compared, structural differences can be seen in their etched patterns.

Summary

This reanalysis brings the composition of the Pittsburgh iron into agreement with that of other meteorites having similar structures. The Pittsburgh iron differs from other iron meteorites that have been found along the southern border of Pennsylvania. The metallography of the meteorite is discussed.

The Breece, New Mexico, Meteorite

Plate 16

An iron meteorite weighing approximately 50 kilograms from near Breece, McKinley County, N. Mex., was described by Beck, La Paz, and Goldsmith (1951) as a medium octahedrite containing lamellae of cohenite. This is the first reported occurrence of cohenite lamellae. Previous to that study, we had examined the Breece meteorite without recognizing cohenite, and after the above-named authors reported cohenite in Reichenbach lamellae we restudied the sample of that iron in the U. S. National Museum.

Our speciment (pl. 16) is very similar to the one pictured by Beck, La Paz, and Goldsmith. We tested each of the lamellae shown in plate 16 by etching tests without getting any typical reactions for cohenite. Powders from these lamellae were also X-rayed, and in each case the pattern proved to be that of schreibersite.

Perry (1944, pl. 47) pictured inclusions similar to those in our plate 16 and referred to them in a way which indicated that he believed them to be troilite. Although he did not call them troilite, Perry described

them "as an example of Reichenbach lamellae remarkable for their fineness and regularity." Since all the other illustrations in Perry's plate 47 were troilite, the inference is that he considered the lamellae in the Breece iron to be troilite.

Two samples, together weighing 21.69 grams and both containing the elongated inclusions which had once been identified as cohenite, were prepared for analysis. Since the densities of these pieces were 7.86 and 7.87, apparently both portions had about equal quantities of these lamellar inclusions. Both samples were dissolved in HCl (1 part HCl, 2 parts H_2O), as a result of which the cohenite and schreibersite should concentrate in the residue. After the kamacitic iron dissolved, a strong magnet was attached to the bottom of the flask to hold the magnetic residue in the container while the solution was decanted off.

A visual examination of this residue showed that it contained two minerals. The most abundant one had the color and luster of the mineral which occurred in the lamellae shown in plate 16. The other was a dark carbonlike particle, feebly magnetic, brittle, and very soft.

Cohenite and Carbon Pseudomorphs of Cohenite

This dark component was unlike anything we had seen in a meteorite. Because of the size of some of these aggregates, it was difficult to believe that they could be common in iron meteorites and have escaped detection until now. Others who had examined this iron apparently had not observed these carbon aggregates. We found them because our sample was dissolved so that the analyst could observe the progress of the acid attack on the meteorite.

Cohen (1897c) found a carbon compound in the Cranbourne meteorite that may have been similar to the carbon we recovered. As the Cranbourne iron contains cohenite, possibly the black carbon aggregrate that Cohen noticed was iron carbide that had become graphitized. When some silicate minerals are attacked by acid they will leave a skeleton made of one of their constituents, and carbon in cohenite may behave in the same way.

The color and luster of these dark bodies from the residue of the Breece iron were remarkably constant. Some were soft, black, and slightly magnetic, others were nonmagnetic. The X-ray pattern was different from those of graphite, cohenite, or schreibersite.

Thus, if cohenite is slightly soluble in dilute hydrochloric acid, possibly it existed in the portion we analyzed from the Breece iron. Its decomposition products may have escaped unnoticed as hydrocarbons, and perhaps those carbonlike aggregates were a product of the reaction of the acid on cohenite.

Cohenite obtained from another meteorite was given a prolonged treatment in dilute hydrochloric acid. Detectable amounts of hydrocarbons were liberated, but, what is more unusual, some carbon pseudomorphs of cohenite formed. Since these had the shape and color of cohenite, the unaided eye could not distinguish them from that mineral. However, these pseudomorphs are essentially nonmagnetic, while cohenite is strongly magnetic. A characteristic

TABLE 7.—*Spacings of unknown black residue from HCl solution of the Breece, N. Mex., meteorite* [1]

Fe Radiation, Fe Kα = 1.9373 Å

Intensity	d (Å)	Intensity	d (Å)
3	4. 46	1	2. 51
3	4. 23	1	2. 34
2	4. 13	5	2. 18
1	3. 73	5	2. 11
1	3. 44	2	2. 06
7	3. 35	3	2. 00
10	3. 06	5	1. 97
9	3. 01	4	1. 93
9	2. 96	3	1. 91
1	2. 88	4	1. 86

[1] By George Switzer.

feature of most cohenite inclusions is the small island of kamacite enclosed within the grains. These carbon pseudomorphs had a sharply defined hole, which must be the place where some kamacite dissolved out.

The soft aggregates of carbon found when the Breece iron was dissolved are possibly similar in origin to the carbon pseudomorphs of cohenite, but perhaps these should be called skeletons or aggregates of carbon.

Although we obtained no such well-defined carbon pseudomorphs when the Breece iron was dissolved, we will concede that these black carbon aggregates indicate that some cohenite was concealed in the sample we dissolved. Although we failed to detect cohenite in that portion of the Breece iron, Beck, La Paz, and Goldsmith isolated and identified some from this meteorite. Those authors, however, were mistaken in reporting that cohenite made up the Reichenbach lamallae, because we tested all the lathlike inclusions and found them to be schreibersite.

Beck recovered enough cohenite to analyze and identify it by X-ray. Because the density Beck reported for cohenite was closer to schreibersite than to cohenite, we became suspicious of the identification. His X-ray film of cohenite matched the lines in our standard

cohenite film, but we could not understand why the lines in his film were indistinct. Now we suspect that the cohenite Beck X-rayed was partly graphitized or carbonized.

Although present in limited amounts in the Breece meteorite, cohenite is difficult to detect; yet it is a rather common mineral in coarse octahedrites. Cohenite apparently becomes less and less abundant as the Ni content increases above that which is normal for the coarse octahedrites. Nickel apparently partly graphitizes or carbonizes the cohenite; thus it is unlikely than an iron meteorite like the Breece would contain more than a trace of cohenite. Furthermore, since carbon pseudomorphs are made by prolonged treatment of cohenite in dilute HCl, possibly the carbon aggregates we found originated from cohenite. Thus, the acid treatment given the sample may have partly carbonized the cohenite that Beck X-rayed.

Chemical Analyses of the Matrix and the Schreibersite in the Breece Meteorite

Table 8 contains all the reported analyses of this meteorite. The failure of Martin (analysis 2) to report phosphorus probably influenced Beck, La Paz, and Goldsmith to call these lamellae cohenite. All the other analyses show phosphorus, and all except No. 5 show only traces of sulfur. Possibly, Carlisle's sample contained a bit of troilite.

TABLE 8.—*Findings, by various analysts, of the chemical composition of the Breece, N. Mex., meteorite*

	(1) *Henderson (new analysis)*	(2) *Martin* [1]	(3) *Herpers* [2]	(4) *Nichols* [2]	(5) *Carlisle* [3]
Fe	89. 627	89. 87	89. 97	90. 06	88. 69
Ni	9. 167	9. 26	9. 46	8. 67	9. 58
Co	0. 635	0. 89	0. 19	0. 62	1. 02
S	trace	0. 11	trace	0. 03	0. 23
C	trace	0. 03	—	—	0. 10
P	0. 571	0. 00	0. 219	0. 47	0. 46
Cl	—	0. 00	—	—	—
Cu	—	0. 00	0. 002	0. 02	—

[1] In Beck, La Paz, and Goldsmith (1951, p. 537).

[2] Personal communication from S. K. Roy, Chicago Museum of Natural History.

[3] Personal communication from L. La Pax, University of New Mexico.

The magnetic portion of the insoluble residue makes up 3.63 percent of the meteorite by weight. If the schreibersite in the material represented by analyses 1, 4, and 5 of table 8 is calculated, all these analyses contain about the same amount of schreibersite.

TABLE 9.—*Chemical composition of the insoluble residue (schreibersite) from the Breece meteorite*

	Analysis by Carlisle	*Ratio*		*Analysis by Henderson*	*Ratio*	
Fe	60.82	1.09		[a] 59.93	1.071	
Ni	24.52	0.418	3.52	24.18	0.412	2.93
Co	0.15	0.002		0.014	0.002	
P	13.19	0.425	1	15.75	0.507	1
S	0.00	0.00		—	—	
C	1.06	0.09		[b] 0.002	—	

[a] By difference.
[b] Carbon not determined, but observed.

The carbon that Carlisle reported, 1.06 percent, was not all derived from the decomposition of cohenite by acid used to dissolve the sample, because if there is 1.06 percent carbon and all of it came from cohenite, the Breece meteorite would contain about 7 percent cohenite. Such quantities of cohenite are not present in this meteorite. Although some of the carbon Carlisle reported may have been derived from cohenite, most of it represents disseminated carbon in the meteoritic iron.

Summary

The mineral in the lamellar inclusions formerly was incorrectly identified as cohenite. This restudy proves that the mineral is schreibersite and confirms the presence of cohenite in this meteorite.

The Tombigbee, Alabama, Meteorite

PLATE 17

The Tombigbee meteorite was restudied because the old analyses reported less nickel than we believed should occur in a hexahedrite. Since hexahedrites are essentially kamacitic iron and usually contain about 5.5 percent Ni, it seemed important to check the accuracy of some analyses reporting low nickel percentages. If such analyses are correct, some explanation must be given for the apparent deficiency of nickel.

This meteorite contains many large schreibersite inclusions as well as rhabdite needles; therefore, it is particularly suited to an investigation of the composition of the phosphide inclusions, the kamacitic groundmass, and the kamacite adjacent to the large schreibersite bodies.

Since the areas to be analyzed were selected from a slice about one-eighth inch thick (pl. 17), it was possible to have some control over the homogeneity of the selected samples. The findings reported

are based upon studies of special areas, thus they do not truly represent the composition of the meteorite. A representative analysis of a meteorite such as this one is possible only if special attention is given to the selection of the sample. To sample the Tombigbee iron properly, it is necessary to get the actual proportion of inclusions and matrix in the main mass. Because of this difficulty the analyses of such a meteorite may vary more than those of the normal hexahedrites or fine-grained octahedrites.

Farrington (1915b) gave a comprehensive summary of the historical and descriptive data on this iron, which he called De Sotoville. Foote (1899) described six specimens that were found along a straight line about 16 kilometers long. Three pieces were from south of De Sotoville in Choctaw County, Alabama, and three from farther north, in Sumter County. It is important to note that the heaviest of the six was the one farthest north and the smallest was at the south. All were found between 1858 and 1886 and were extensively altered when discovered.

Classification

This meteorite has been classified in three different ways: Berwerth (1903) called it an ataxite; Klein (1903) called it a finest octahedrite; and Farrington (1903) noted its cubic character. Brezina and Cohen (1904) observed that different pieces of this iron had different structures. They said:

> Mass 1 considered by itself alone, may be regarded as hexahedral iron; Mass VI, as the same, though possessing in places a granular structure, while in Mass III only traces of Neumann lines are visible . . . . It must be assumed that various masses of the De Sotoville iron were originally normal hexahedrites and in varying degree of extent were subject to agencies which wrought a change of structure. Probably different degrees of heating may account for the difference, which in the case of some of the masses may have been carried to the extent of softening or complete melting of the entire mass . . . . It cannot be determined with certainty whether the masses in question were heated by the finders, as so often happened in the case of meteoric iron, or whether a secondary softening took place before or during their fall . . . . Since, however, in the neighborhood of the displacement and veins, occur structural changes similar to those of the apparently thermally altered portions, the conclusion may be drawn that the thermal process is also not of artificial or terrestrial origin, but of the same cosmic nature as the mechanical changes; and that through heating and pressure there was a gradual change of a hexahedral iron into an ataxite . . . .

Perry (1944) classified the Tombigbee iron as a hexahedrite. It has a clear primary granulation and shows no diffusion around the phosphide needles. Neumann lines are profuse but delicate, and their diverse orientation in the grains is similar to that occurring in typical hexahedrites.

Although taenite and plessite may be present in this iron, they were not observed. The numerous dark spots scattered through the

meteorite are, we assume, phosphide particles; however, they are visible only in higher magnification and are distinct from rhabdite. The kamacite shows a microscopic granulation, but no evidence was found of any octahedral arrangement.

Chemical Composition

An area containing a large schreibersite inclusion and a narrow zone of enclosing kamacitic iron was selected from the prepared slice for an analysis of both the kamacite and schreibersite. The portion selected, which weighed 23.379 grams, was placed in HCl (1 part HCl, 2 parts H_2O) until all the kamacite dissolved. The analysis of the acid-soluble part gives the composition of the kamacite adjacent to the schreibersite. The insoluble residue, the schreibersite, was then dissolved in HNO_3 and separately analyzed, table 10.

TABLE 10.—*Chemical composition of swathing kamacite and schreibersite in the Tombigbee meteorite*

	Swathing kamacite	*Ratio*	*Schreibersite*	*Ratio*	
Fe	[a] 95. 64	1. 712	71. 78	1. 285	} —2. 98
Ni	3. 78	0. 064	12. 03	0. 205	
Co	0. 58	0. 009	0. 58	0. 009	
P	—	—	15. 59	0. 503	—1

Mol. ratio $\frac{Fe}{Ni+Co}=23.45$

[a] By difference.

The average molecular ratio $\frac{Fe}{Ni+Co}$ for hexahedrites is about 16.50. This average does not include several octahedrites that have been incorrectly classified as hexahedrites. It does include several analyses which we suspect are not entirely accurate. Thus, a molecular ratio of 23.45 for swathing kamacite is so different from the average kamacite in a hexahedrite that some reason must be given in explanation.

The material analyzed in table 10 consisted of 16.8 percent schreibersite and 83.2 percent kamacite. Probably the material analyzed as swathing kamacite was a mixture of kamacite adjacent to the phosphide and some of the groundmass. In some unpublished studies we found that the swathing kamacite around schreibersite bodies contained several percent less Ni than the groundmass of the meteorite.

A composite analysis, calculated from the analyses of the matrix and the schreibersite in table 10, shows that the abundance of Fe, Ni, and Co in an area made up of both kamacite and schreibersite is similar to that in a normal hexahedrite.

TABLE 11.—*A composite analysis of an area in the Tombigbee iron consisting of kamacite and schreibersite, and an average analysis of hexahedrites*

	(1) *Composite analysis of an area consisting of kamacite and schreibersite*	(2) *Average of hexahedrites*
Fe	91. 86	93. 76
Ni	5. 10	5. 51
Co	0. 64	0. 56
P	2. 64	—
FeS	0. 016	—
Insol.	0. 01	—
Mol. ratio $\frac{Fe}{Ni+Co}$	17. 13	16. 45

A comparison of the molecular ratios of a composite analysis of a section of the Tombigbee iron with that of an average of 39 iron, 41 nickel, and 39 cobalt determinations on different hexahedrites shows that the Tombigbee iron is a hexahedrite rich in phosphide inclusions.

Other areas from the matrix in this iron were analyzed to verify the composition of the matrix. These analyses are given in tables 12 and 13. Swathing kamacite contains 0.55 percent less Ni than the average of the analyses of the ground mass (table 14). However, it is more than likely that the swathing kamacite studied was contaminated by some of the matrix. Possibly the kamacite adjacent to the phosphide contains less Ni than our findings report.

TABLE 12.—*Chemical composition of the average kamacite in groundmass in the Tombigbee meteorite, remote from any schreibersite inclusions*

	Grams	*Percent*	*Ratio*
Fe	10. 5570	94. 19	1. 687
Ni	0. 4927	4. 39	0. 074
Co	0. 0773	0. 69	0. 011
P	—	—	
Insol.	0. 0070	0. 06	
	11. 1340	99. 33	

Mol. ratio $\frac{Fe}{Ni+Co}=19.84$

Weight of original sample, 11.208 gm.
Weight of recovered material, 11.134 gm.
Unaccounted for, 0.074 gm. (0.66 percent).

All the unaccountable portion in table 12 should not be assigned to an error in the iron determination, although some of it may belong there. After all the soluble material had dissolved, the insoluble

residue had such a low density and was so finely divided that the solution could not be decanted without carrying off some of the residue. Unfortunately, this solution was decanted onto a paper filter and when an effort was made to recover the residue enough was embedded in the filter to account for most of the loss.

Another sample of the matrix was selected at some distance from a schreibersite body to confirm the composition of the matrix and to get enough rhabdite to determine its nickel and cobalt content.

The portion selected, weighing 28.603 grams, was dissolved in 1 part HCl and 4 parts H_2O in a flask. The vapors were condensed and returned to the solution to prevent the acid from concentrating. The insoluble residue weighed 0.2425 gram and consisted of magnetic particles that had the identical form and color of the rhabdite we had recovered from other meteorites. Thus, the matrix of the Tombigbee iron contains about 1 percent of rhabdite.

This residue was dissolved in HNO_3 and HCl so that the nickel and cobalt determinations could be made. The matrix of this iron, the portion that dissolved in the 1–4 HCl, was partially analyzed. Both analyses are given in table 13.

Table 13.—*Partial analyses of the kamacite and rhabdite in groundmass in the Tombigee meteorite*

	Kamacite	*Rhabdite*
Fe	[a]95. 09	—
Ni	4. 28	19. 53
Co	0. 63	0. 58
P	None	[b]
Cu	—	trace
Insol.	—	0. 83

[a] By difference.

[b] Qualitatively confirmed but not determined.

The point we desire to prove is that the kamacite adjacent to the schreibersite is essentially different from the matrix that is remote from these large phosphide bodies. The data for the preceding tables that support this contention are summarized in table 14.

Table 14.—*Comparison of analyses of the Tombigbee meteorite*

	Composite analysis	*Kamacite in groundmass*		*Swathing kamacite*
	(Table 11)	(Table 12)	(Table 13)	(Table 10)
Fe	91. 86	94. 19	95. 09	95. 64
Ni	5. 10	4. 39	4. 28	3. 78
Co	0. 64	0. 69	0. 63	0. 58
P	2. 64	—	—	—

TABLE 15.—*Summary of Analyses on the Tombigbee meteorite*

	Kamacite							*Schreibersite*		*Rhabdite*[1]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Foote, 1899	*New data (Swathing kamacite)*	*Brezina and Cohen, 1904*	*New data*	*New data (Partial analysis)*	*Cohen, 1905*	*Cohen, 1905*	*New data*	*Cohen, 1903*	*New data*
Fe	95. 86	95. 64	95. 40	94. 19	95. 09	95. 22	95. 60	71. 78	71. 70	60. 98
Ni	3. 62	3. 78	3. 83	4. 39	4. 28	4. 02	4. 34	12. 03	12. 58	19. 53
Co	0. 36	0. 58	0. 71	0. 69	0. 63	0. 65	—	0. 58	0. 32	0. 58
P	—	—	—	—	—	—	—	15. 59	15. 45	—

[1] See discussion on page 377.

A comparison of the nickel content of the swathing kamacite with that of the kamacitic groundmass shows that the kamacite adjacent to the schreibersite contains less nickel. We believe this to be the first time that this has been shown. In table 15 the nickel content of the schreibersite is shown to be between 12.03 and 12.58 percent and that of the rhabdites 19.53 percent. Thus, the rhabdite contains about 7 percent more nickel than the schreibersite.

All available previous analyses of the Tombigbee meteorite are given in table 15.

The Ni content of the kamacite in the matrix of this iron ranges between 3.62 and 4.39. The analyses of schreibersite agree fairly well. Brezina and Cohen (1904) noted that the Tombigbee schreibersite was unusually low in Ni and asked if the rhabdite in this iron contained more Ni than the schreibersite. The new analysis confirms the low Ni content of the schreibersite, and the partial analysis of the rhabdite shows that the smaller phosphide bodies contain much more Ni than the schreibersite.

Farrington (1915a) listed 24 schreibersite analyses. The one with the lowest Ni, 10.72 percent, came from the Zacatecas meteorite (Cohen 1897a, p. 49). Only five of those analyses had less than 15 percent Ni. In the Tombigbee iron the Ni is near the average of the hexahedrites, the schreibersite contains slightly more than twice as much Ni as the matrix, and the rhabdite has between four and five times as much as the matrix. It will be interesting to see if similar differences exist in other meteorites of this type.

A Theory for the Origin of Swathing Kamacite

The partition constant governing the distribution of Ni between kamacite and schreibersite is unknown. We suspect that the phosphide molecule which existed while the matrix was at higher temperatures was essentially an iron phosphide. At temperatures just below those at which the Ni-Fe alloy solidified, the phosphide probably was a liquid and was deficient in Ni.

At temperatures above 1000° C. the Ni-Fe matrix is a solid and in the gamma phase, but the phosphide is still a liquid. At this temperature the nickel entering the phosphide and replacing iron is assimilated by the phosphide. The replaced iron solidifies because the temperature is below its melting point. These particles of rejected iron migrate to the edge of the phosphide.

The above process happens simultaneously with the formation of the Ni-impoverished zone surrounding the phosphide inclusion. The diffusion rate of iron into the matrix must be slower than the rate at which nickel enters the phosphide; otherwise these swathing zones

would not exist. Thus, we suspect the following theory outlines the origin for the swathing kamacite around schreibersite inclusions.

The swathing zone represents a reaction zone. Possibly the liquid phosphide that segregated at a high temperature was essentially Fe_3P, and the Ni-Fe matrix that enclosed it was in the gamma phase. As Ni migrates from the matrix into the phosphide, Fe is replaced. The rejected Fe which migrated to the edge of the phosphide together with the enclosing Ni-impoverished zone effectively sealed off the available source of Ni. Thus, the swathing kamacite may represent two processes, the rejection of the iron from the phosphide and the formation of a zone of Ni-impoverished iron in the matrix that enclosed the schreibersite.

Perry (1944) reports eutectic structures in schreibersite bodies in the Chesterville, Cincinnati, and Rio Loa meteorites. He explains the structures by saying that the schreibersite bodies were remelted and that the liquid phosphide absorbed kamacite from the groundmass. Then, as the liquid cooled, the absorbed Fe, in the excess of the Fe-Fe_3P eutectic ratio, was rejected in the form of droplike particles in the interior and in a border around the periphery.

Whatever process produced these droplike kamacite particles that occur within the phosphide inclusions, we suspect their presence indicates that the temperature was lowered too rapidly for the drops to migrate the short distance to the periphery of these bodies. This idea is supported by the way these features occur in the Cincinnati and the Rio Loa irons, although in those meteorites the structures were found in the zone of alteration.

In all probability the swathing kamacite is made during the original cooling. The metal in the zone containing both Ni-impoverished iron and the iron rejected from the schreibersite is in the gamma phase and, being Ni-poor, transforms to kamacite at higher temperatures than those at which the matrix will transform. The swathing zones around sizable schreibersite bodies are wider than the kamacite lamellae within the Widmanstatten structures because the displaced iron from the phosphide accumulated against the Ni-impoverished iron.

There is no difference in the appearance of the matrix in the Tombigbee iron and the swathing kamacite because both are kamacitic iron. However, the matrix and the zone adjacent to the phosphide inclusions have different hardnesses (table 16). We have also observed differences in the chemical composition of swathing zone around schreibersite and the matrix in other meteorites.

At the time the Ni-Fe alloy solidified, most of the phosphide had been rejected as large liquid blobs. Some phosphide, however, dissolved in the matrix and that portion became enriched in nickel.

Phosphide is more soluble in taenite than in kamacite. Both the taenite and rhabdite, which separate as the temperatures are lowered, contain increased percentages of nickel. The information needed to follow the changes in composition that occur in the phosphide that separates from the matrix as cooling takes place is not available.

Hardness Measurements on Swathing Kamacite

A series of Knoop hardness tests were made on the Tombigbee meteorite at the Department of Metallurgy, Massachusetts Institute of Technology, through arrangements made by Prof. H. H. Uhlig. These values, given in table 16, show a progresive increase in hardness as the distance from the phosphide increases. The Knoop hardness

TABLE 16.—*Knoop hardness numbers on swathing zone around schreibersite, load 100 grams, in Tombigbee meteorite*

Test	*Knoop No.*
1	211. 6
2	253. 0
3	246. 3
4	253. 0
5	233. 9
6	246. 3
7	253. 0
8	274. 5

values confirm the analytical results by showing that there is a difference in the composition of the metal in the swathing zone around schreibersite bodies and in the matrix.

The lowest value reported was 211.6, and the highest 274.4. The higher value we suspect is essentially that of the matrix. Dalton (1950) reported that the hardness of hexahedrites is consistent at about 180 on the Knoop scale and that the hardness of kamacite in octahedrites is approximately 260.

Hexahedrites Containing an Abundance of Schreibersite

The La Primitiva, Chile, iron (Cohen, 1897b, p. 123) is rich in schreibersite and was classified as an altered hexahedrite. We assume that Cohen meant the meteorite had a structure modified by reheating rather than weathering or chemical alteration. Prior (1914), in a description of the Angela, Chile, meteorite, said this iron "is honeycombed by schreibersite, which on one piece is estimated to amount to nearly a quarter of the mass." La Primitiva and Angela are now regarded as the same meteorite.

The kamacite in the Soper, Oklahoma, iron (Henderson and Perry, 1948b) is unusually low in nickel. Here the numerous phosphide inclusions occur as small masses between kamacite grains. Apparently,

this iron solidified before the phosphide could coalesce. With the phosphide scattered as small bodies, the contact between the schreibersite and kamacite is greater than if the schreibersite is segregated into one large body. Hence, a favorable opportunity existed for the phosphide bodies in the Soper to acquire more nickel than did the schreibersite in the Tombigbee iron. The Soper schreibersite contains 15.61 percent Ni, while the large inclusions in the Tombigbee contain only between 12.02 and 12.58 percent.

TABLE 17.—*Chemical composition of kamacite in the Soper, Angela, and La Primitiva meteorites*

	Soper	*Angela*	*La Primitiva*
Fe	93. 35	95. 03	94. 72
Ni	4. 11	4. 52	4. 72
Co	0. 51	0. 65	0. 71
P	—	trace	0. 18

Since the above analyses of the groundmass of the Soper and Angela meteorites are free from phosphorus and were made on material containing no schreibersite, all the nickel belongs to the kamacite. The La Primitiva analysis shows 0.18 percent P, or about 1.2 percent schreibersite. If this mineral contains the same percentage of nickel as the Soper schreibersite, and if the La Primitiva analysis was corrected for that amount of schreibersite, then the nickel content of the kamacitic groundmass in La Primitiva is approximately the same as that found in Angela.

Summary

Analyses of the matrix, the metal adjacent to the large schreibersite bodies, the large schreibersite, and the rhabdite needles of the Tombigbee meteorite are given. The distribution of Ni in the matrix is uniform, but the zone of swathing kamacite immediately enclosing the large schreibersite contains less Ni than the matrix. The evidence indicates that large schreibersite bodies became enriched in Ni. The diffusion of Ni from the matrix into the swathing kamacite zone or the diffusion of the rejected iron from the phosphide into the matrix was not fast enough to equalize the abundance of Ni in the matrix and the swathing kamacite. The hardness measurements show a difference between the matrix and the swathing kamacite. Thus, the matrix of those hexahedrites which have many large phosphide bodies enclosed within them may contain less nickel than the average hexahedrite. A few analyses of other meteorites of this type are given.

The Soroti, Uganda, Africa, Meteorite

PLATES 18,19

Fall and Description

The Soroti meteorite fell about 12 miles northeast of Soroti, Uganda, Africa (lat. 1°41′ N., long. 33°38′ E.) at 1.10 (probably p. m.) on Sept. 17, 1945. It was named after the native village of Soroti by R. O. Roberts (1947), who first described it and to whom we are indebted for both the historical records and the samples we studied.

The District Commissioner at Teso, in a report dated Sept. 22, 1945, stated:

. . . at almost exactly 10 minutes past one on Monday 17th of September, a low rumble, as of thunder, but without claps, was heard. It was, indeed, so similar to thunder that people indoors took little notice for half a minute. It rose slightly in volume and its persistence soon drew everyone to look skyward. Many thousands of feet high (wild guess is 20,000) a vapor trail could be seen. This trail extended across the sky which was clear as it could be. After about a minute the sound abruptly stopped. The trail disintegrated after about 5 minutes. Everybody had a different idea as to the direction, I personally thought north-south, another European thought south-north, and all points of the compass were mentioned.

A woman from Melok village, about 3 miles southwest of Katine Etem (Gombolola) Headquarters said, "I was sitting in my hut with my three children yesterday morning. I heard something like thunder. So I went out of my hut and went to a tree nearby with my oldest child. I told him to kneel down and pray to God. We had just knelt down, when a thing came from the sky and went into the ground near the tree. I and my child were blinded by smoke for a little while. When we could see again, I went to the place where the thing had fallen."

There was found a small crater a foot deep and only 3 feet from the spot where they had been praying. Other pieces of metal were found scattered around within a radius of a mile or more. Some are believed to have fallen in Omunyal Swamp.

Pieces brought to the District Office evoked great interest and some 500 people had seen it within an hour of the arrival in Soroti. Many hundreds more have come to see them since.

Summarizing, it may be stated that the phenomenon was observed in Eastern Buganda, at Aloi, 18 miles to the East of Lira in Lango District, at Budaka, 17 miles west-south of Mbale, in Mbale District, and at Soroti and Tosoma, in Teso District, that is, within an area of at least 4,200 sq. miles. Fragments of the meteorite are known to have fallen only in Teso, particularly near Soroti.

The velocity of the Soroti meteorite at the time the native woman heard the noise may have been greater than the speed of sound, although the terminal velocity of the piece which struck near her was not high. Of course it is impossible to prove that the sounds first heard originated when those pieces were sheared off, for probably

many pieces were broken off the meteorite while it was decelerating. Most of these pieces either were essentially consumed in the air or fell unnoticed and have not as yet been found.

Thus, possibly the noise that the woman heard originated back along the path of the meteorite. Sound waves travel at greater speeds than those at which the fragments would fall, so that the noise could be heard several seconds before any of the pieces landed. The sounds that were heard may have been produced when the meteorite encountered or passed through the sound barrier. The noises which alerted the native mother possibly were made after the pieces were broken off.

We were given the two small specimens for restudy and a picture of all four specimens. The approximate weights of the four Soroti specimens are 1,000, 700, 190, and 170 grams.

The specimens consist of nickel-iron and troilite and have rough surfaces similar to that of a pallasite. Numerous bits of metal protrude from the surface of the specimen, some of them partly coated with a black fusion crust in which delicate flight markings are preserved. The troilite is covered with a thicker crust of fusion products than the Ni-Fe alloy, probably because troilite melts at a lower temperature.

The cross section through the two Soroti specimens (pl. 18, top) shows that the distribution of the metallic veins determined the shape of the meteorite. The troilite is held by the Ni-Fe alloy in the same way that olivine is held in the pallasites.

Apparently the troilite on the surface receded by ablation during the flight slightly faster than did the metallic phase and for reasons given on page 392. The troilite exposed on the surface is badly fractured, indicating that mechanical action probably had as much to do with the loss of troilite as thermal action.

The black crust covering many of the troilite areas on this meteorite may be essentially the fusion product of troilite, although possibly some material from the Ni-Fe alloy contaminates it. In color and texture, the fusion crust on the troilite is indistinguishable from the crust on the Ni-Fe alloy, but there is no reason to suppose that it should be otherwise.

The unique character of this meteorite, we believe, makes it worthy of a class name. The name sorotiite is proposed for meteorites consisting of Ni-Fe and troilite which have structures similar to those of the pallasites.

Normally one studies the polished surface of a slice through a meteorite and then selects a typical area from that slice for the chemical analysis. As it did not seem desirable to slice either of these

two small specimens and consume the material in the chemical analysis, we decided to cut them in half with a hacksaw and use the cuttings in the analysis.

A few of the pieces of metal that fell off during the cutting had some troilite attached to them. These were picked out, and with the use of a steel needle we then removed much of the troilite. These pieces were next hammered on a steel block in an attempt to break off more troilite, and although most of the remaining troilite was removed, possibly some of it was beaten into the iron. After the battered pieces of metal were brushed to remove the loosely attached troilite, they were added to the magnetic portion of the saw cuttings. Dust from the hacksaw blade may possibly have contaminated the sample, and some troilite may have been lost as a fine powder, but we estimate that these disadvantages were more than offset by the advantages of having cross sections from two pieces of this iron available for study and of preserving more material.

The magnetic material from the saw cuttings, consisting of Ni-Fe alloy and schreibersite, was placed in a flask and covered with 1 part of HCl and 3 parts of H_2O. The gas given off was passed through acidified lead acetate solution. The portion that dissolved in hydrochloric acid was decanted off for analysis. The magnetic residue, later identified as schreibersite, made up 0.98 percent of the sample. The lead sulfide that formed in the lead acetate solution was converted to lead sulfate and calculated as sulfur.

The results given in table 18 closely approximate the composition of the Ni-Fe phase and the troilite. Roberts (1947) gives Fe as 91.13 and Ni as 8.87. As our sample was of necessity prepared in a manner not entirely satisfactory, we prefer to consider the results as a partial analysis.

TABLE 18.—*Partial analysis of the Soroti meteorite*

	Ni-Fe phase	*Ni-Fe phase including schreibersite*	*Troilite*	*Schreibersite*
Fe	83. 51	84. 21	62. 80	—
Ni	12. 67	12. 80	—	13. 75
Co	0. 62	0. 62	—	n. d.
P	0. 00	0. 15	—	15. 65
S	0. 81	0. 81	35. 84	—
Fe	[a] 1. 41	1. 41	—	—
Schreibersite	0. 98	—	—	—
Cr	—	—	[b] 0. 062	—
Insol.	—	—	0. 53	—

[a] Calculated from sulfur.

[b] Determined on separate sample.

The percentages of Fe, Ni, and Co in the metallic phase of the Soroti iron agree with the composition of the meteorites in table 19. Metallographically the Alt Bela (Smycka, 1899) and the Illinois Gulch (Cohen, 1900) irons are different. The Widmanstatten structures of the Carlton (Howell, 1890), Edmonton (Henderson and Perry, 1947), and Soroti meteorites are so similar that it would be difficult to distinguish between them if only the Ni-Fe phases were compared.

TABLE 19.—*Iron, nickel, and cobalt content of four meteorites that are similar chemically to the Soroti.*

	Soroti	*Edmonton* [1]	*Carlton* [1]	*Alt Bela* [2]	*Illinois Gulch* [2]
Fe	84. 21	86. 61	86. 54	85. 34	86. 77
Ni	12. 80	12. 57	12. 77	12. 89	12. 67
Co	0. 62	0. 79	0. 63	0. 41	0. 81

[1] Also similar metallurgically to Soroti.
[2] Different metallurgically from Soroti.

Roberts (1947) reported the density for the largest Soroti specimen to be 5.86. The density of a meteorite like the Soroti would vary depending upon the proportion of Ni-Fe to troilite. The measured densities of the four halves of our two specimens were 5.98, 6.11, 6.16, and 6.24. An average of all the reported densities on this meteorite is 6.07, but since there was a little oxide on each specimen, the true density would be slightly higher than 6.07. Henderson and Perry (1954) demonstrated that the densities of hexahedrites, coarsest octahedrites, and nickel-poor ataxites can be calculated very closely from the chemical analyses. It is not known, however, whether the density of a meteorite containing as much plessite as the Soroti can be accurately calculated. The density of the magnetic portion was found to be 7.864 by substituting the needed data in the following formula, but a density so determined may be low because the magnetic portion contained 2.22 percent of troilite.

Where S=schreibersite, T=troilite, and d=density:

$$\text{Density of magnetic portion} = \frac{100}{\frac{\%\text{ of Fe}}{\text{d of Fe}} + \frac{\%\text{ of Ni}}{\text{d of Ni}} + \frac{\%\text{ of Co}}{\text{d of Co}} + \frac{\%\text{ of T}}{\text{d of T}} + \frac{\%\text{ of S}}{\text{d of S}}}$$

The analysis of the Ni-Fe portion probably should be corrected for the 2.22 percent FeS before the density is calculated, because there is not that much troilite in the metallic portion of this meteorite. Table 21 gives the analysis of the magnetic portion of the Soroti meteorite before and after it was corrected for troilite.

TABLE 20.—*Recalculation of the partial analysis (table 8) of the Soroti meteorite*

	Ni-Fe phase including schreibersite	*Composition of schreibersite deducted*	*Percentage of components in Ni-Fe analysis*
Fe	84. 21	0. 71	83. 50
Ni	12. 80	0. 137	12. 67
Co	0. 62	0. 01	0. 61
P	0. 15	0. 15	—
FeS	2. 22	—	2. 22
Schreibersite	—	—	0. 99

TABLE 21.—*Analysis of the magnetic part of the Soroti iron before and after deducting the troilite; also, the calculation of the density of the metallic phase*

	Percentage of components in Ni-Fe analysis	*Analysis after deducting FeS, calculated to 100%*		*Density of constituents*		*Quotient*
Fe	83. 50	85. 41	÷	7. 86	=	10. 866
Ni	12. 67	12. 96	÷	8. 90	=	1. 456
Co	0. 61	0. 62	÷	8. 90	=	0. 069
Schreibersite	0. 99	1. 01	÷	7. 00	=	0. 144
Troilite	2. 22	—		—		—
						12. 535

$$\text{Density corrected for troilite} = \frac{100}{12.535} = 7.977$$

Roberts (1947) calculated the density for the metallic phase at 7.95, but the formula he used is not entirely reliable.

The relative proportions of N-Fe and troilite in the Soroti can be obtained by the following formula, where

x = weight percentage of troilite
$100-x$ = weight percentage of Ni-Fe
6.07 = average density of meteorite
7.977 = calculated density of Ni-Fe
4.77 = density of troilite

we have

$$\frac{x}{4.77} + \frac{100-x}{7.977} = \frac{100}{6.07}$$

By the above calculation, the troilite makes up 46.727 percent and Ni-Fe 53.274 percent by weight of this meteorite. To make the percentage more useful to the reader who examines plate 18 (top), the weight percentage of troilite has been recalculated to volume percentage as follows:

$$\frac{\text{Weight percentage of troilite}}{\text{Density of troilite}}=\text{Volume proportion of troilite} \qquad (1)$$

$$\frac{\text{Weight percentage of Ni-Fe}}{\text{Density of Ni-Fe}}=\text{Volume proportion of Ni-Fe} \qquad (2)$$

Substituting in equation (1) we have

$$\frac{46.727}{4.77}=9.796,$$

and substituting in equation (2) we have

$$\frac{53.274}{7.977}=6,678.$$

Thus, the total volume proportion of troilite and Ni-Fe is 16.474. Reducing to volume percentage of troilite we have

$$\frac{9.796}{16.474}\times 100=59.46.$$

And reducing to volume percentage of nickel-iron we have

$$\frac{6.678}{16.474}\times 100=40.45$$

Summarizing, the Soroti meteorite has 46.727 percent of troilite and 53.274 percent of nickel-iron by weight; and it has 59.46 percent of troilite and 40.54 percent of Ni-Fe by volume.

Metallography

The unique feature of this iron is the ratio between the troilite and the Ni-Fe, although neither phase by itself is unusual. Of all the many meteorites that have been studied, none resembles this iron. It is therefore unlikely that numerous examples of this type will be found, but it does not necessarily follow that such meteorites could not be relatively abundant among those that enter our atmosphere.

The kamacite bands in the Soroti, measured in the direction of the cut, have a width of less than 1 millimeter. Schreibersite, which so commonly occurs between the troilite and the metal in other irons, in this case is essentially within the Ni-Fe alloy. The zone of swathing kamacite that encloses the entire Ni-Fe portion is nearly twice as thick as the average kamacite lamella in this meteorite. Since nickel does not replace iron in troilite, as it does in schreibersite, the additional widths of swathing kamacite must have a different explanation from that given for the swathing kamacite around the schreibersite in the Tombigbee iron (p. 379). Possibly troilite at higher temperatures had some excess iron which, as cooling took place, was rejected and the swathing kamacite was produced.

Troilite is both immiscible in molten Ni-Fe and of lower density than Ni-Fe. Hence, if FeS and Ni-Fe were slowly cooled from a melt, the FeS, or troilite, should completely segregate from the Ni-Fe phase and exist as a liquid above the solidified Ni-Fe phase. The abundance of plessite and the narrow kamacitic lamellae are interpreted to indicate a rather rapid cooling or perhaps a sudden relief of pressure.

Although the mechanism of producing a meteorite containing about 50 percent troilite dispersed in a network of Ni-Fe alloy is not understood, the process should be no more complicated than that which produces a pallasite. If an acquiescent body of molten material with the composition of a pallasite slowly cooled, olivine would solidify before the Ni-Fe. As the density of olivine is lower than that of Ni-Fe, it should completely separate itself from the metal if the cooling takes place slowly in an appreciable field of gravity. Due to surface cohesion, the olivine might carry up some metal, but surely not enough to account for the Ni-Fe in pallasites.

Apparently such a simple condition did not exist in the case of the Soroti. Thus, it is pertinent to speculate about the conditions that did exist and those which seem to be consistent with the structures and mineral assemblages found in pallasites and in meteorites like the Soroti. Pallasites probably cooled from a magna, with the olivine solidifying first. Regardless of its lower density, the olivine in pallasites is mixed with Ni-Fe alloy, indicating either that the body in which the pallasites formed was small or that there were no appreciable gravitational forces. Pallasites or meteorites like the Soroti iron could, however, be made in a large body if the process took place near the center, because there the gravitional forces would be neglibile.

Troilite in the Soroti meteorite is analogous to the olivine in pallasties, and for this reason the comparison of the occurrence of olivine and troilite in meteorities should be pursued further. Olivine is much more abundant than troilite in stony meteorites, but less so in iron meteorites. Occasionally olivine occurs in an iron meteorite which is not a pallasite, but such an iron could originate adjacent to a pallasitic aggregrate.

Abundance of Troilite in Meteorites

Troilite is relatively abundant in meteorites. According to Daly (1943), the chondrites contain about 5 percent FeS and the achondrites about 1.5 percent. According to these figures troilite is 4 times more abundant in chrondrites and 12 times more abundant in achondrites than it is in metallic meteorites. However, the sections of meteorites in museum collections and the pictures of sections in published descriptions do not support Daly's figures.

A preliminary investigation of the abundance of troilite in a few irons was made. If there were more troilite than the above data indicate, it would support our contention that material such as that occurring in the Soroti iron could exist in quantities in the body from whence meterorites came.

Daly probably obtained his figures for sulfur from the chemical analysis, but our experience indicates that this is the wrong place to get such information. An author describing an iron meteorite is generally more interested in the metallic matrix than in an inclusion like troilite. Thus, the analyses of most of the irons are not suited for the calculation of sulfur because the troilite areas were not included in the portion selected for study.

To investigate this, the sulfur in a number of irons was calculated. The sulfur content of four coarse octahedrites (table 22) was established by measuring the width across a section and then measuring the total distance occupied by troilite along that line. Similar parallel traverses were made at one-eighth inch intervals.

TABLE 22.—*Comparison of sulfur percentages determined chemically by analyses of coarse octahedrites with sulfur percentages determined statistically by measuring sections from the same meteorites*

(The sulfur chemically determined is a weight percentage and is not equivalent to sulfur reported in the last column, which was obtained after estimating the percentage of troilite in the total area of a slice.)

Meteor	Chemical determination		Statistical determination	
	Reference	% Sulfur	% Troilite in section	% Sulfur in section
Coolac, Australia	Hodge-Smith, 1937	1.27	4.76	1.73
	Henderson, 1951	none		
Canyon Diablo, Ariz	Noissan, 1904	trace	5.95	2.17
	Barringer, 1905	0.004		
	Merrill & Tassin, 1907	0.005		
	Merrill, 1913	0.01		
	Buddhue, 1950	0.13		
Odessa, Tex	Merrill, 1922	0.03	3.43	1.15
	Beck & La Paz, 1951	0.02		
Osseo, Canada	Marble, 1938	None	3.42	1.25
Wichita County, Tex			2.72	1.00

When more than one section of a specimen was measured, a weighted average was calculated for the percentage of troilite. We do not claim that the coarse octahedrites selected are representative for that group. Only a small number of sections have been measured through the Canyon Diablo and the Odessa meteorites, whereas there are tons of the Canyon Diablo and possibly many hundreds of pounds of the Odessa iron. Also the areas that were measured on both were too small to represent either meteorite. Yet the percentages so obtained appear to be more reliable than the values Daly reported after calculating the analysis of a sample weighing but a few grams.

The measurements reported in table 22 were made on the same meteorite that the chemist analyzed but not on the same sample.

Troilite (stoichiometric FeS) with NiAs crystal structure is exclusively a meteoritic mineral, with the one exception of the Del Norte, Calif., occurrence. According to Eakle (1922), the California troilite occurs in a serpentine in an old copper mine. Apparently no specimens were found with the troilite in the matrix. We are not challenging the terrestrial origin of the California troilite, but it is important to keep its uniqueness in mind. If the theory proposed in the following pages for the disintegration of a meteorite made of about 50 percent troilite and 50 percent Ni-Fe is correct, possibly meteoritic troilite is scattered over the earth; however, the chances of finding such specimens would be very slim indeed.

Meteorites Like the Soroti Are Likely To Be Consumed in Flight

All meteorites are fragments of some large cosmic body. It would be impossible for a meteorite such as the Soroti to be broken from its parent mass without acquiring a rough and hackly surface, with projecting veins of metal extending slightly beyond the troilite. Also, the troilite occurring all over the surface and perhaps that occurring slightly below the surface would be fractured, as troilite is brittle at normal temperatures. In the Soroti, such troilite probably was brittle at the temperature existing when the original body broke up. (Gunard Kullerud, of the Geophysical Laboratory, reports in personal communications that FeS made at 550° C. appeared to be more brittle than FeS made at 400° C.)

Most meteorites seen in collections have rather evenly rounded surfaces, but this does not mean that they entered our atmosphere with a smooth surface. Possibly a prominent external irregularity on a mass entering the atmosphere is removed during the interval the meteorite undergoes its maximum deceleration. After the meteorites with homogeneous textures become rounded, their dimensions probably decrease only slightly during the remainder of their flight.

A surface made up of either troilite or olivine held in a network of metal will not become smooth because of stresses and strains. The mechanical forces applied to such a surface supplements the loss of material by normal thermal ablation; hence the vapor trails from such meteorites should be more pronounced and enduring than those from homogeneous meteorites.

The most violent reactions occur on the forward face of a falling meteorite. Enough energy was released in the collision of the air molecules with the Soroti meteorite to vaporize both the Ni-Fe alloy and the troilite. Many irons show that heat-softened metal flowed over their surfaces. Troilite, which has a lower melting point than

the Ni-Fe alloy and is brittle, was either burned away or mechanically lost at a faster rate than the Ni-Fe alloy. Thus an aggregate of minerals like the Soroti, in which small veins of metal protrude from the surface, loses more material from its surface than the average meteorite. Furthermore, the reduction possibly continues through more of the flight than in the case of a homogenous meteorite.

After the velocity of the Soroti meteorite was decelerated to a point where the temperature on its front face was not high enough to heat the sides, possibly physical action continued to disintegrate the brittle troilite. A spine of Ni-Fe alloy extending beyond the surface might, by means of the atmospheric drag, be bent backward. If this happened, the spine of Ni-Fe would fracture the sulfide against which it is pressed, with a simultaneous breaking of the bond between the metal and the troilite on the forward side of the metallic spine.

Such a falling meteorite may undergo major changes in its form during flight, and, if so, it probably would not hold a fixed position. If such a body tumbles during its high-velocity flight, fractures would be produced and widened between the metal and the troilite over all surfaces. Such violent action may shatter more of the troilite and cause the loose pieces to fall out. As the troilite is lost, more rough metal surfaces would become exposed, and these, in turn, would be subjected to the shearing-off process.

Thus, the stresses and strains applied to these meteorites with hackly surfaces, such as those of the Soroti type and the pallasites, cause material to be lost as long as the mass is moving with a velocity high enough to cause bending of the metallic veins. Troilite, because of its low melting point, should react to the temperatures on the front of such a meteorite after the other minerals have ceased to react. In addition, the FeS and Ni-Fe portions have different thermal conductivities and coefficients of expansion. Therefore, both thermal and mechanical stresses are operating simulteneously on the surface of such a meteorite during its fall.

Summary

This meteorite fell Sept. 17, 1945, at 1.10 (probably p. m.) near Soroti, Uganda, Africa. Four pieces were recovered, together weighing 2,060 grams. The composition and metallography of the meteorite are given. The abundance of sulfur in iron meteorites is discussed, and a probable reason is given for the variety of such meteorites as the Soroti iron. This iron represents a new type of meteorite, analogous to the pallasites, with troilite taking the place of olivine. The name sorotiite is proposed for this type.

The Keen Mountain, Virginia, Meteorite

PLATES 20–22

A 14.75-pound iron meteorite, a new hexahedrite, was found in 1950 by Fred Matney at approximately 30 feet from the crest of the south face of Keen Mountain, Buchannon County, Virginia, near the head waters of Pigeon Branch. The coordinates of the point of discovery are lat. 37°13′ N., long. 82°0′ W.

Mr. Matney observed this dark object along a path he frequently used. It attracted his attention because it was noticeably different from the other rocks. When he discovered it was metallic he cut off a small piece and sent it to the U. S. Geological Survey, Washington, D. C. Dr. Charles Milton, of the Survey, suspected it was a meteorite and referred the correspondence to the U. S. National Museum.

When Mr. Matney learned that his specimen was a meteorite and that the National Museum was interested in it, he offered to bring it to Washington on his next trip north or hold it until someone from the Museum would visit him. Gordon Davis of the Geophysical Laboratory, Washington, D. C., was in the Museum shortly after this specimen was identified, and, since he was going to Buchannon County, Virginia, he offered to negotiate with Mr. Matney for the meteorite.

When Mr. Davis delivered the iron to Washington, Stuart H. Perry bought it and presented it to the National Museum.

Description

The Keen Mountain meteorite probably fell recently, although the fall was not witnessed. On its surface there are sizable patches of unaltered black fusion crust that contain flight markings. In a few places the silver color of the Ni-iron alloy can be seen through the fusion crust. However, on the surface of this iron, patches of loosely attached oxide as well as some small corrosion pits occur. The meteorite, according to Mr. Davis, was found at a place where it would be wet by ground seepage for about four months of each year. Probably no iron meteorite would remain fresh in such an environment very long. Although it is impossible to establish the year it fell, we suspect its weathered surface could develop within five or ten years if it was wet as much of the time Mr. Davis estimates. Thus, the Keen Mountain iron possibly fell between 1940 and 1950.

Apparently this fall attracted no local attention. Mr. Matney, who lived close to where the meteorite was found, did not associate it with any meteor display. Finding this iron near the top of the southern slope of Keen Mountain indicates that it did not come from a northerly direction.

The rough areas shown in plate 20 are due to surface alteration. Some of the corrosion pits range between 2 and 4 millimeters in width and are about the same in depth. When this meteorite was received the pits were nearly filled with loosely bonded brown iron oxide. The rust was removed from most of these places to probe the depth of the oxidization.

The depression in the central part of plate 20 (top) is about 7 or 8 millimeters deep. After 2 or 3 millimeters of oxide were removed from this cavity, troilite was exposed at the bottom. The bottom dimensions of this cavity are approximately 8 by 10 millimeters, while the diameter at the surface is nearly 15 millimeters. Apparently, during the flight of this iron through our atmosphere, this depression increased in diameter faster than it deepened.

The surface of the iron surrounding this cavity is covered with fusion crust containing flight markings. However, some oxidization is superimposed on some parts of the fusion crust. Since the surface of the iron surrounding this depression has a black crust over it, this feature was made during the flight of the meteorite in our atmosphere. Some of the troilite in this depression was burned away during the flight, so the heat generated on the surface was not sustained long enough to remove all the sulfide.

The delicate striae preserved in the glossy fusion crust and the shape of this meteorite indicate that the forward face during most of its flight through the atmosphere is the one shown in plate 20 (bottom).

A study of the surface features of unaltered meteorites is important but unfortunately this topic has not attracted much attention. Plate 20 shows the surface features of the Keen Mountain iron and permits others to interpret these features.

The Keen Mountain meteorite cannot be paired with any other meteorite. If other pieces fell they have not been found, and if such pieces are not discovered soon they will be weathered and it will be difficult to relate them to this iron.

The other known hexahedrite from Virginia was found 100 miles east of Keen Mountain, at Indian Valley, Floyd County, in 1887. It was described by Kuntz and Weinschenk (1892) who said:

> In the spring of 1887 a mass of meteoritic iron was turned up by John Showalter while plowing his tobacco patch, situated in Indian Valley Township near Carroll and Pulaski lines and near the base of the south side of Floyd Mountain, 6 miles south east of Radford Furnace, Virginia . . . . This meteorite weighs 31 pounds . . . . The surface of the iron is very much corroded and is entirely covered with a limonite crust, only a little of the original crust is visible. On the exterior are deep depressions from 2 to 4 cm. in diameter.

Although both hexahedrites were found on the southern face of mountains we believe this is only a coincidence.

A slice 2.5 millimeters thick was cut for study (plate 21, bottom) and three areas were selected for density determinations. We assumed that the area with the highest density was the purest kamacite, so this portion was analyzed.

TABLE 23.—*Density measurements of three areas from one slice of the Keen Mountain meteorite before and after the oxide was removed*

Area	*Density of piece as it was removed*	*Density of piece after oxide was removed*
1	7. 766	7. 907
2	7. 908	7. 908
3	7. 859	7. 895

Composition

All but a small proportion of area 2 (table 23) dissolved in dilute HCl. The insoluble part was filtered off, weighed, and found to have the crystal habit of rhabdite. A partial analysis of this residue is shown in table 24. The rhabdite in this section of the Keen Mountain iron makes up 0.98 percent by weight.

The nickel content of the rhabdite was determined. We obtained phosphorus by calculation, because rhabdite has a fixed phosphorus content.

TABLE 24.—*Analysis of the acid soluble part of the Keen Mountain meteorite, a partial analysis of the reside, and a calculated composite analysis of the meteorite*

	(1) *Portion that dissolved in HCl*	(2) *Partial analysis of rhabdite*	(3) *Composite analysis of the meteorite*
Fe	[a] 92. 92	[a] 46. 80	93. 38
Ni	5. 28, 5. 27	37. 7	5. 65
Co	0. 72	[b] 0. 50	0. 73
P	0. 04	[b] 15. 00	0. 19
S	none	none	none
C	0. 06	—	0. 06
	100. 00	100. 00	100. 00

Molecular ratio $\frac{\text{Fe}}{\text{Ni}+\text{Co}}=16.46$

[a] By difference.
[b] See discussion (p. 397).

The composition of the meteorite may be estimated by combining the analyses in columns 1 and 2 of table 24. The cobalt content in several rhabdite analyses averaged about 0.50 percent; therefore, that value was assumed to be present. The iron in each case was

obtained by difference. Chemically the composite analysis is similar to other hexahedrites.

Both the Cincinnati (pl. 10) and the Keen Mountain (pl. 22) meteorites have eutectic structures; also, some phosphorus in both irons dissolved in acid. Possibly the process that produced these eutectic structures had something to do with the making of the phosphides soluble. Certainly the phosphorus in both meteorites originally was either in a rhabdite or schreibersite body and was insoluble in dilute hydrochloric acid. In the analyzed specimen of the Keen Mountain iron, 25 percent of all the phosphorus dissolved in dilute acid.

All the insoluble residue, which consisted of rhabdite needles, was used in a nickel determination. Unfortunately, there was not enough material for a complete analysis. The rhabdite in the Keen Mountain iron contains about 37 percent nickel.

The sulfur content was determined by estimating the volume of troilite in the slices shown in plate 21 (bottom). The volume percentages (3.49 and 4.25, obtained by two different methods) were averaged, and 3.91 percent is reported for the troilite content of this meteorite.

Since only a few slices have been removed from this meteorite, we do not know whether they represent an average for this iron. More sulfur than phosphorus is present in the slices thus far removed. However, there may be more phosphorus in the Keen Mountain iron than sulfur because the phosphides are uniformly dispersed through the metal while sulfur occurs as localized troilite.

Hexahedrites as well as all iron meteorites probably contain much more sulfur and phosphorus than their analyses indicate. Possibly the error in the abundance of sulfur is greater than the error in the abundance of phosphorus.

Metallography

The zone of granulated metal immediately underlying the crust (pl. 21) usually is assumed to represent the penetration of heat into the meteorite during its flight. It is important to establish where the greatest thermal penetration occurs on oriented meteorites. Nininger (1940) said that it was unreasonable to expect the front face of oriented meteorites to show the deepest penetration of heat because the maximum ablation occurs on the front of a falling meteorite.

Two sections cut through the Keen Mountain meteorite (pl. 21) show a zone of granulation around the edges of the cuts. The thickness of the zone is not uniform in both slices. The slice with the widest zone of granulated metal was removed where section AA′

crosses the specimen (pl. 20, top). The place where the granulation is the widest corresponds to the lower edge of what we believe was the front face. Our opinion about the orientation of this specimen was based on the shape of the meteorite and on the flight markings.

The Bruno, Canada, iron (Nininger, 1936) is another example of thermal alteration within a hexahedrite. Unfortunately, the illustration Nininger used did not show the magnification; therefore, it gives one the impression that the heated zone around this iron is unusually thick. On a recent visit to the American Meteorite Museum in Sedona, Ariz., we examined the iron and found that the pictures Nininger published in both 1936 and 1952 were enlarged nearly three times. Thus the thermal penetration into the Bruno iron is about the same as occurs in the Keen Mountain specimen.

The Neumann lines in plate 21 (top) are curved, but this is not the first time such Neumann lines have been observed. Such lines indicate some deformation after the Neumann lines formed because originally they were straight.

Some normal rhabdite occurs in the kamacite in this meteorite but two unusual habits for rhabdite are shown in plate 22 (top). Both rhabdites are made up of fragmented particles. One consists of a localized path of similarly orientated particles separated by a narrow channel of kamacite. The other phosphide inclusion is an elongated wavy-body, but in place of being a continuous unit it consists of a series of broken segments.

When these phosphides formed they possibly were no different from the normal phosphides seen in most meteorites. We think these unusual habits indicate a thermal reaction: the matrix was heated high enough for the phosphide particles to react with the surrounding alloy. Since these peculiar phosphide inclusions occur close to the surface, they may have been made during the flight of the iron through the atmosphere. This and other evidence indicates that a study of the phosphide inclusions within meteorites may provide an excellent means of determining the thermal penetration into iron meteorites.

The manner in which the rhabdite was obtained for the analysis precluded it from being anything but an average of the phosphide particles in this meteorite. The Keen Mountain rhabdite, which contains 37 percent of Ni, falls within the upper limits of the nickel values for rhabdite. Unfortunately, there are not enough analyses of this mineral to determine if this rhabdite is unusually rich in nickel.

The rhabdite from the Annaheim, Canada, meteorite (Johnston and Ellsworth, 1921) had 41.36 percent Ni; and the rhabdite in the Cranbourne, Australia, meteorite (Cohen, 1897c) had 42.16 percent Ni.

Both of these irons are coarse octahedrites, so there is more nickel available for the rhabdites to acquire than there is in the Keen Mountain meteorite.

Plate 21 (top) shows a phosphide body consisting of a cluster of orientated particles separated by channels of kamacite. Some structural features, possibly Neumann lines, extend to the border of these phosphide bodies. Some acicular features existing in the kamacite may be structures of a rapidly cooled metal. Such cooling would arrest the solution of the phosphide in the kamacite.

While a high temperature is sustained in the Ni-Fe alloy, nickel may migrate from the kamacite into the phosphide where it replaces iron that is returned to the kamacite. All Ni-Fe phase diagrams show that the solubility of nickel in kamacite decreases as the temperature is raised. The nickel content of schreibersite varies; thus, as the temperature is increased, nickel must enter this mineral from the kamacite because there is no other place for nickel to come from.

The solubility of the phosphide in kamacite apparently increases as the temperature is raised. To understand the thermal changes observed in this iron, some knowledge of the temperature-time relationship for the structures in meteoritic iron is needed.

There are rhabdites in the center of this piece that have a normal habit. Their presence indicates that reheating took place after the mass was broken from the body in which it was formed. Although reheating may have occurred prior to the flight through our atmosphere, most likely these changes were made during the flight in our atmosphere. The thermal changes noted in the Keen Mountain iron are not as extensive as those described in the Social Circle, Georgia, meteorite (Henderson and Perry, 1951) or the Murnpeowie, Australia, meteorite (Spencer, 1935).

Since the diffusion of Ni and Fe is slow, there is a possibility that the changes noted in the phosphide inclusions in the Keen Mountain meteorite took place outside our atmosphere. Although almost everyone will agree that the thermal changes noted around the outside of the Keen Mountain iron were made during flight within the atmosphere, there is a possibility that the zone of metal in which these thermal changes are preserved is the remains of some more extensive thermal reaction that took place around the outside of the mass prior to its entry into our atmosphere.

The increased solubility of the phosphide in the kamacite probably has more to do with the formation of the jagged boundaries of these phosphide bodies than the molecular exchanges of Ni and Fe. In the Cincinnati, Ohio, iron (pl. 10) we found eutectic structures similar to those in the Keen Mountain iron. We believe the eutectic structures resulted from the phosphide particles reacting with the kamacite

when the temperature was raised. The cooling which followed apparently was rapid, and since all the iron that separated as blebs did not get beyond the limits of the phosphide body, some small blebs of iron were trapped (pl. 22, bottom).

All the various structures described in the Keen Mountain meteorite were observed in a single slice. However, the phosphide inclusions arranged parallel to the Neumann lines in the center of the slice are enclosed by a zone of granulated metal around the edge; this means that the reheating occurred after the Keen Mountain iron was small.

There is no data on the rate heat will penetrate a hexahedrite, and we do not know the temperature at which the peculiar features noted in these phosphides will form. Moreover, the zone of granulated metal around the edges of the section indicates that no sizable pieces were broken off during the flight of this mass in our atmosphere.

Apparently most students of meteorites think that iron meteorites fall as single bodies, but it is possible a large hexahedrite could separate along a cleavage and produce several smaller bodies. A fusion crust would form over the fragments and perhaps some thermal penetration would start the moment the larger mass breaks into pieces. Stony meteorites break during their fall and produce individual pieces that are covered with fusion crust, so why can't irons occasionally behave in the same manner?

Summary

A new 14.75-pound hexahedrite from Buchanan County, Virginia, is described. Chemical analyses of the matrix and the rhabdite inclusions are given. Certain metallographic features resulting from the penetration of heat into the meteorite are described.

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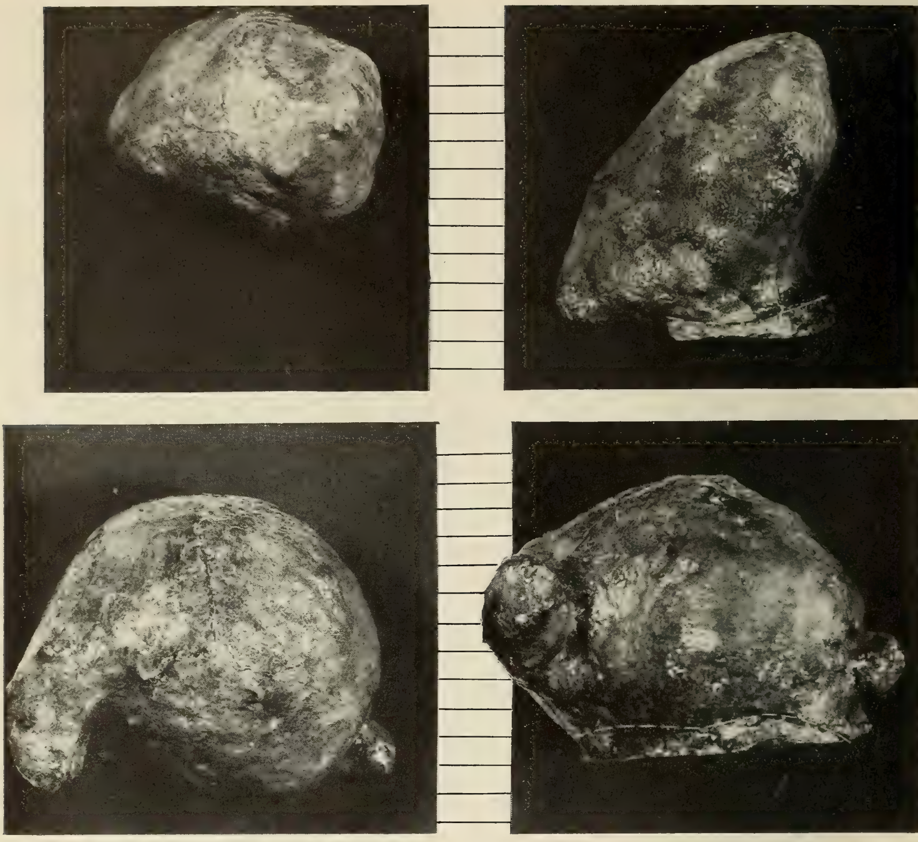
General view of the Goose Lake meteorite. Note the rim of curled metal bending into the large cavity at the left. (Chabot Observatory photograph.)

View of the Goose Lake meteorite. This probably is the rear face of the meteorite because it has fewer layers of deformed metal than the opposite side. Both white rods are 8 inches long. The upper one shows two cavities, which are connected below the bridge of metal. The hole below the upper end of the rod connects with the cavity under the metal bridge. A model of the large cavity at the center of the picture is shown in the bottom photographs of plate 4; its volume is 686 cc. The small round hole near the bottom center with one end of the white rod showing is the opening of the tunnel through the meteorite. The flat area, upper right, is where the slices were cut off.

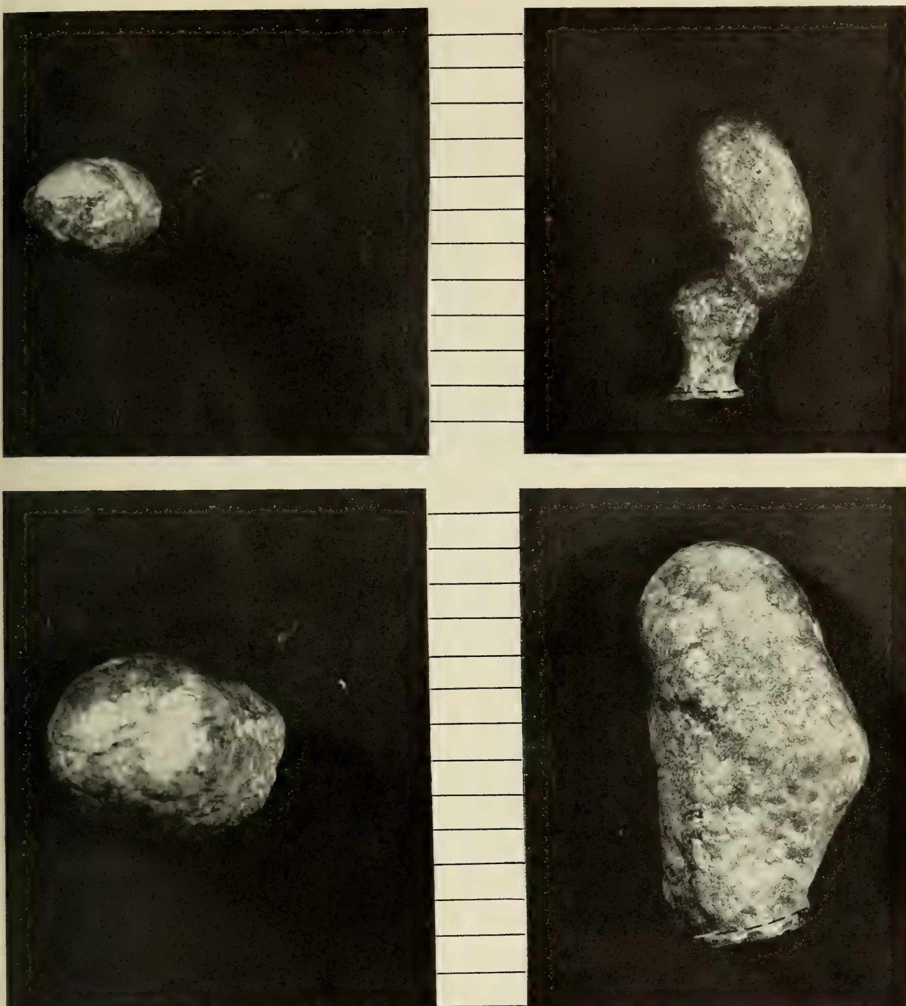
A view of a portion of the face of the Goose Lake meteorite. It is assumed that this portion was part of the front face during most of the fall because there are more layers of deformed metal. A model of the cavity, left of center, is shown in the lower photographs of plate 5. The arrow locates the large cavity leading to the tunnel.



Top.—Two views, normal to each other, of a cast of a depression on the rear face of the Goose Lake meteorite. In the photo at right, the lower left corner of the cavity is close to the surface of the meteorite; the broken line at bottom indicates where the surface of the meteorite crosses at the opening.

Bottom.—Two views, normal to each other, of a cast of a hole in the meteorite. The dotted line on photograph at right locates the opening to the surface of the meteorite.

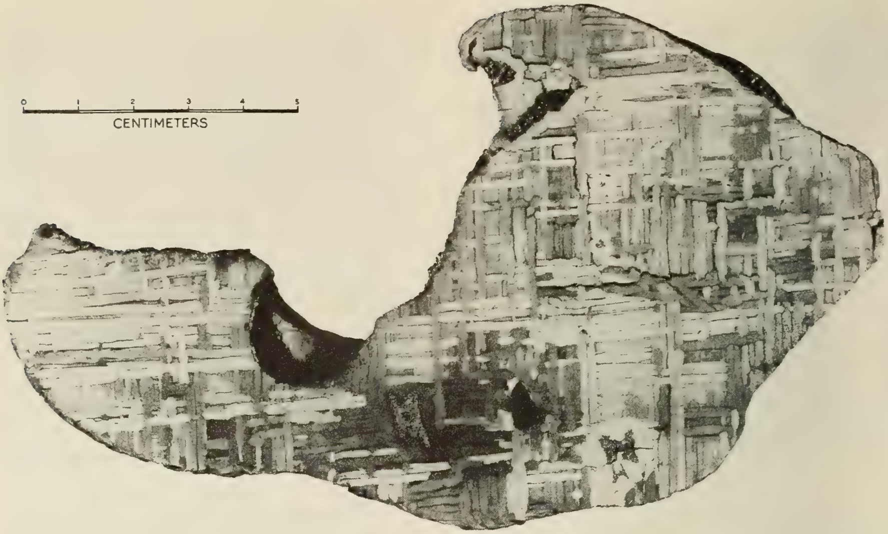
The space between lines in the center strip represents 1 cm.



Top.—Two views, at right angles to each other, of a cavity in the Goose Lake meteorite that appears to be twisted and restricted in width about midway of its depth. The diameter of the opening at the surface is approximately 50 percent of the maximum width of this cavity.

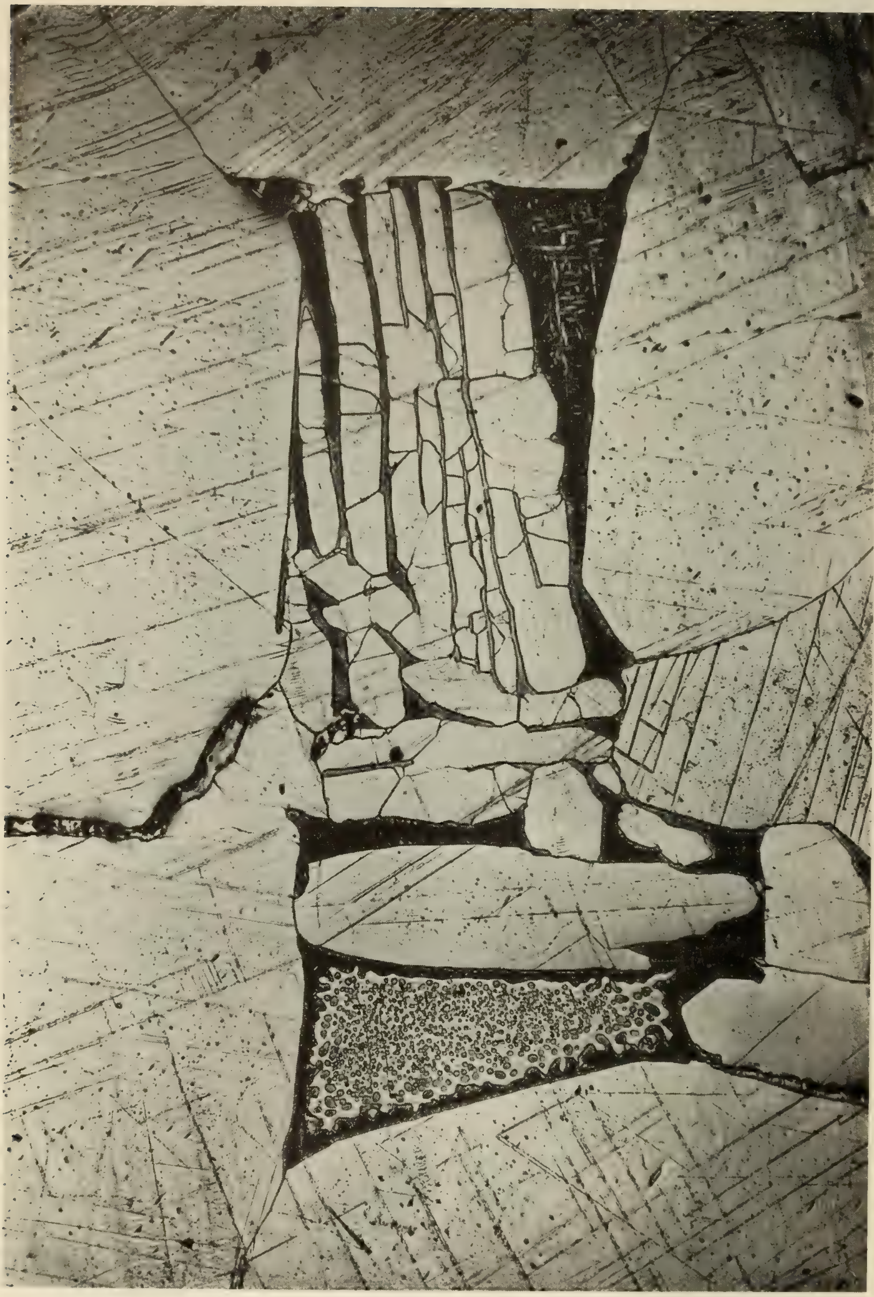
Bottom.—Two views, at right angles to each other, of a cast of a cavity in the forward face of the meteorite. The width of the cross section at the widest point is about double the diameter of the surface opening.

The space between lines in the center strip represents 1 cm.

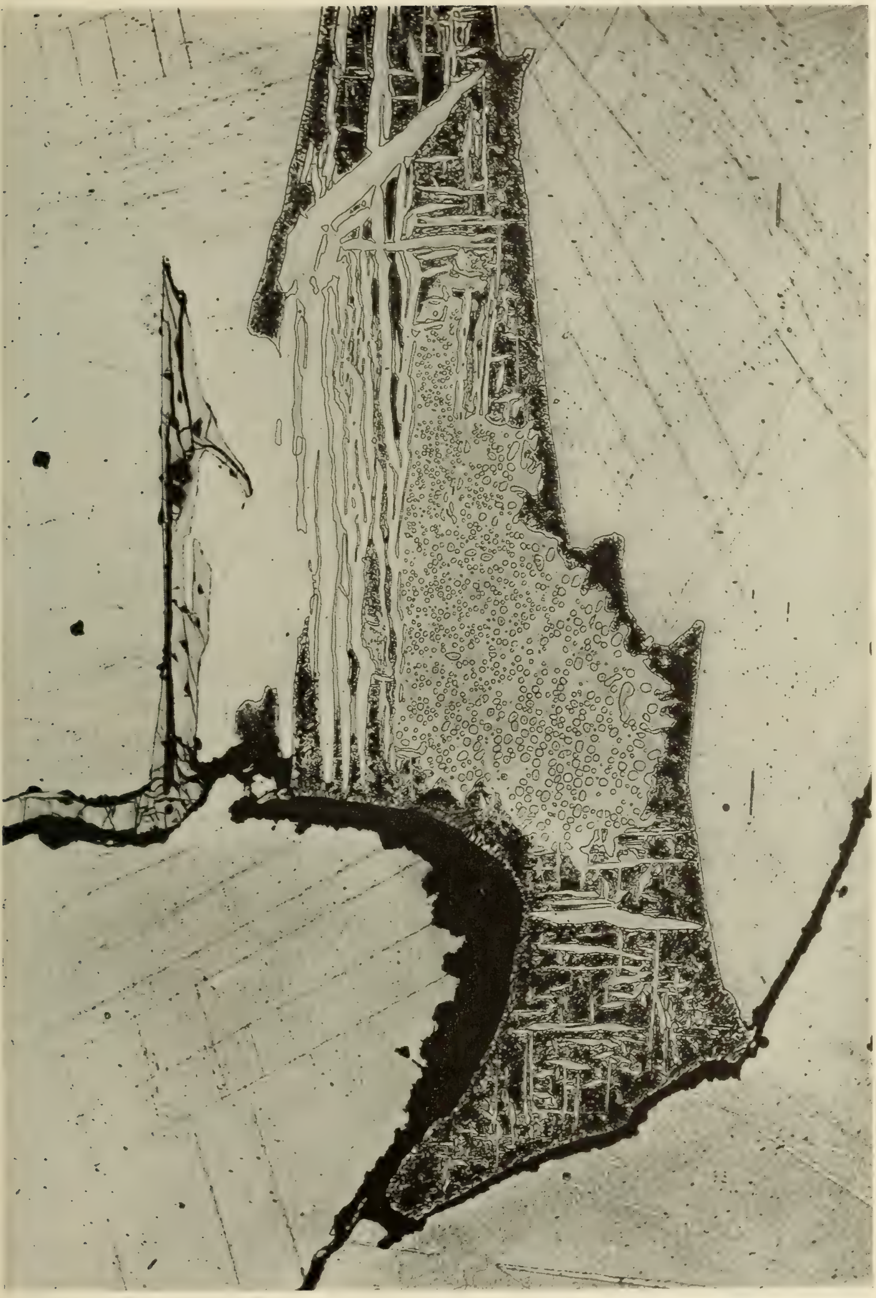


A cross section through a wide but shallow cavity in the Goose Lake meteorite. The dark crescent is the shadow formed by the bent lip, which has curled back into the depression until it reaches the plane of the cut. Note the curved kamacite at the upper edge of the cavity. The Widmanstatten structure runs to the limits of this cavity. At the edges, the structure appears slightly distorted because the metal is so thin that it was deformed by the grinding and polishing.

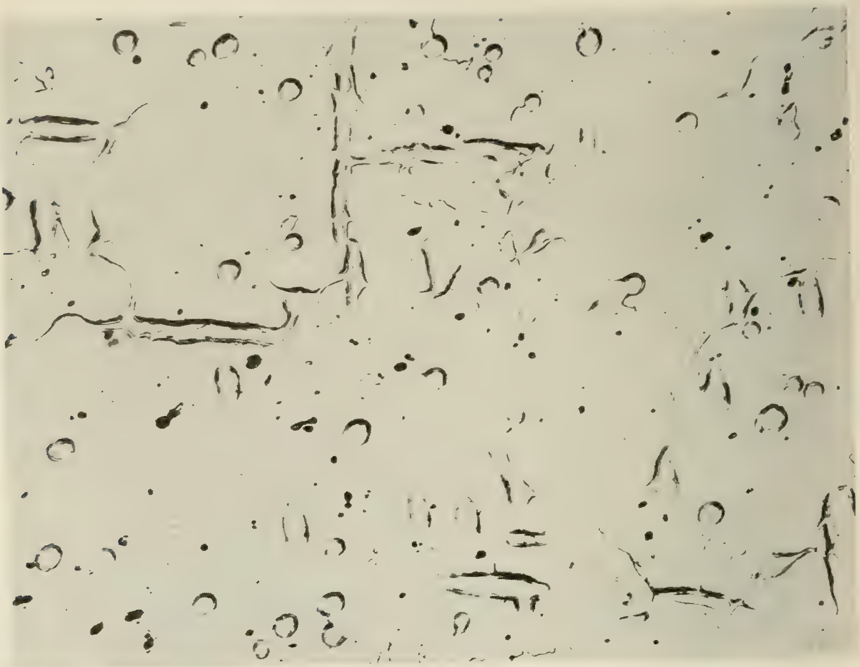
The Goose Lake meteorite is a coarse octahedrite. Numerous plessite areas occur between the kamacite bands. Elongated schreibersite bodies disrupt the Widmanstatten pattern. The thin dark veins lying between the kamacite lamellae were injected during flight.



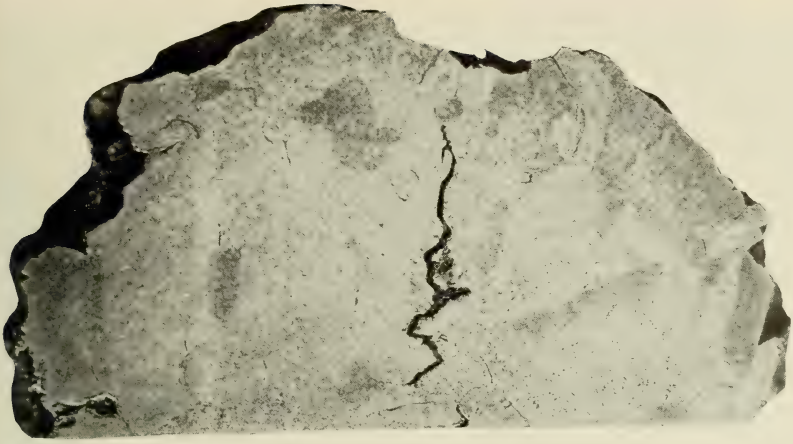
An irregular atypical plessite field about 1 inch below the surface of Goose Lake meteorite. Area at bottom is filled with spheroidized taenite and enclosed by a dark border of imperfectly transformed taenite. Rest of the field is kamacite with some darkened taenite. Dark area in the upper right corner is imperfectly transformed gamma-alpha mixture with orientated (white) kamacite lamellae. Small schreibersite bodies are at the left and at the upper left corner of the plessite field. (Picral applied for 30 seconds; magnification, 100.)

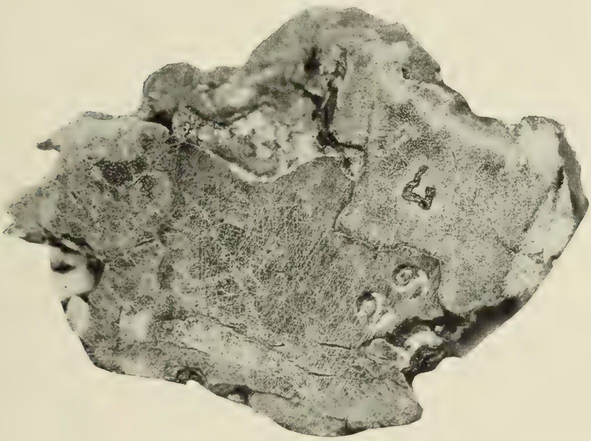


A plessite field in the Goose Lake meteorite, the central part of which shows spheroidized taenite. At the top, left, and bottom, the kamacite lamellae are orientated. At center left is an irregular schreibersite body. Invading hydroxide, due to weathering, appears as dark area along a grain boundary (lower right), a border along the lower end of the plessite field as a much thicker curved area, and adjacent to the schreibersite body. (Picral applied for 30 seconds; magnification, 100.)



The Cincinnati meteorite. Explanation on facing page.





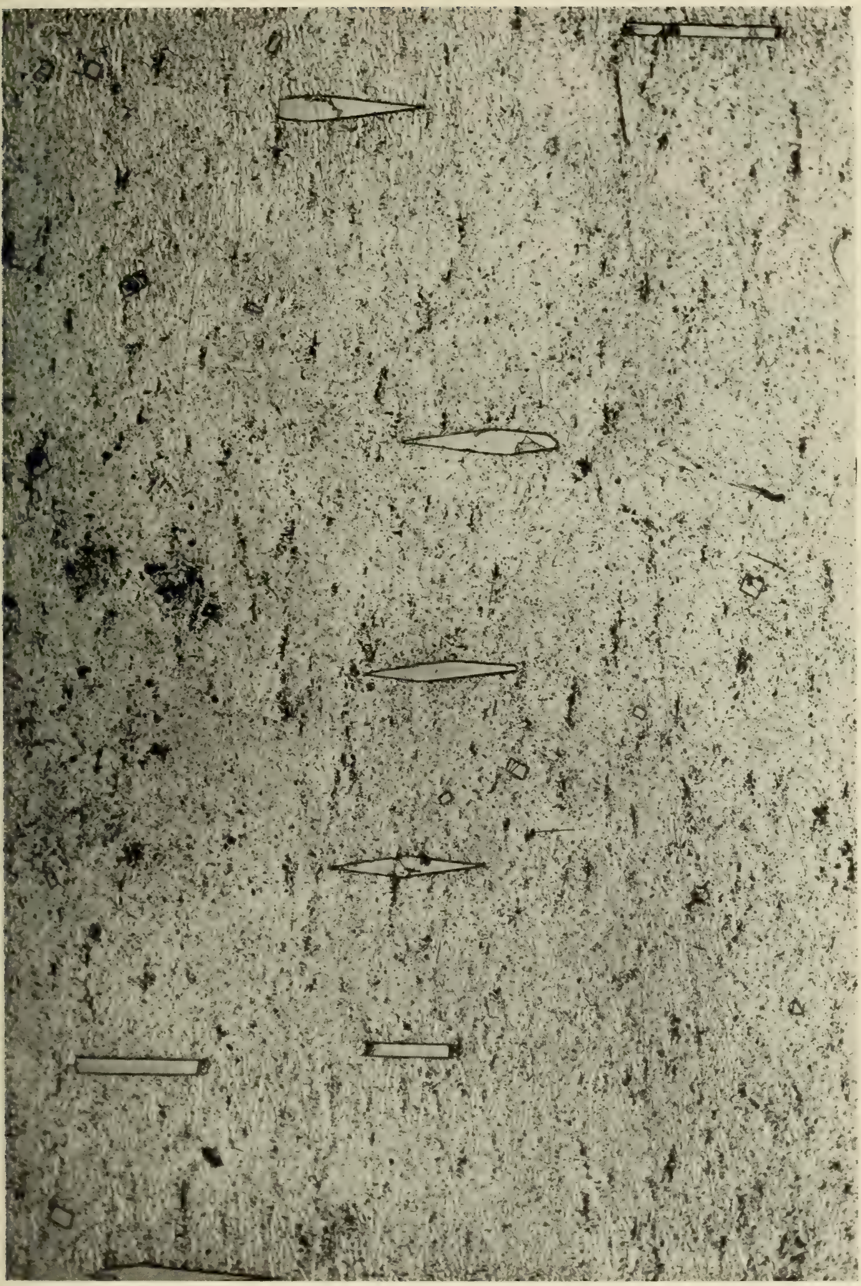
Slices of the Pittsburgh meteorite. The slice shown at top was lent by Yale University; that shown at bottom was lent by Harvard College. (Magnification, 2.)

Explanation of Plate 10 (Opposite)

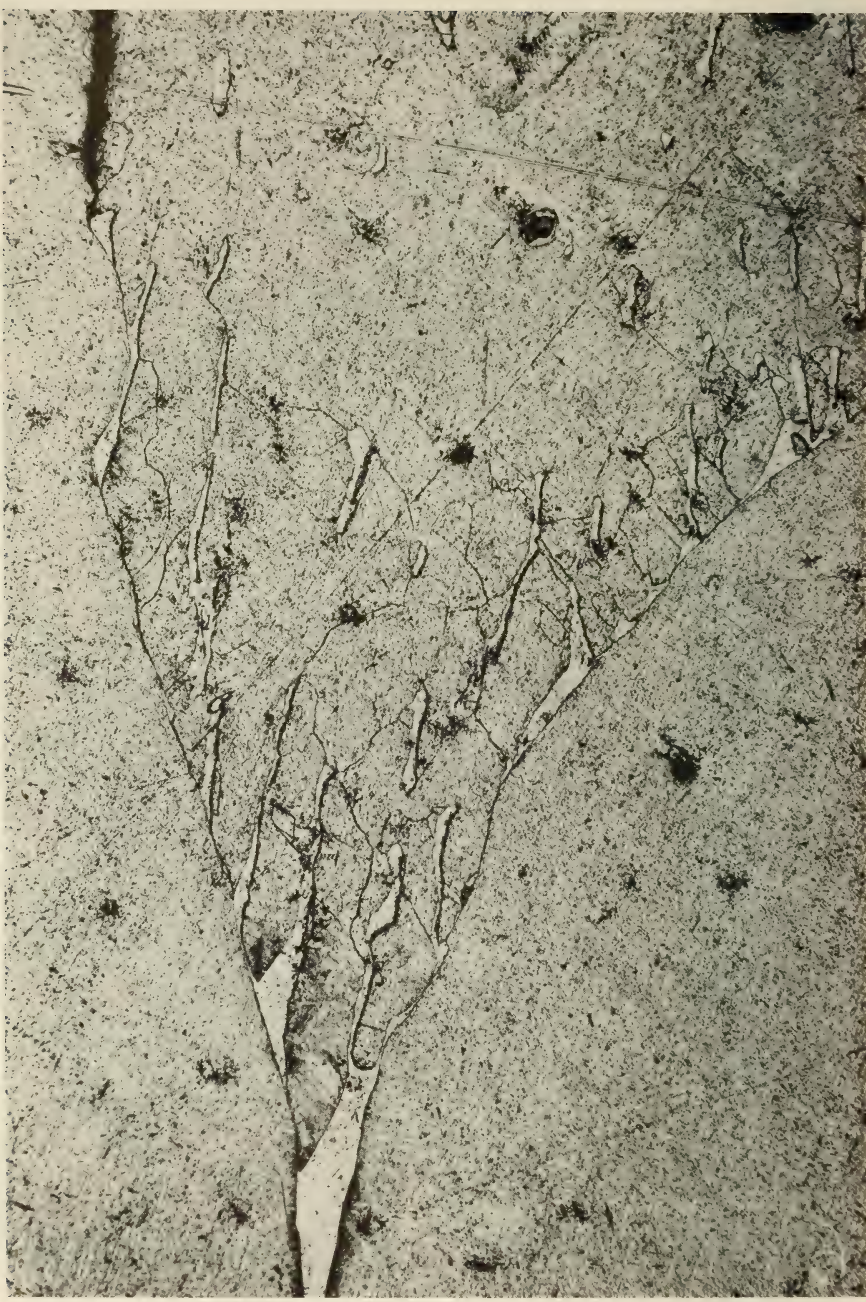
The Cincinnati meteorite. Top.—The phosphides in the Cincinnati meteorite are rounded and appear to have been diffused by reheating. This structure indicates that reheating was for a brief interval and was followed by quick cooling. (Picral applied for 40 seconds; magnification, 150.)

Bottom.—An iron phosphide eutectic of unusual fineness and regularity. The excess of iron that was rejected in the cooling was unable to migrate to the edge of the structure. A feature with such perfect structure is indicative of slow cooling. (Picral applied for 60 seconds; magnification, 100.)

An area in the central part of the Cincinnati meteorite showing numerous rhabdites. Many of these have frayed ends and some have irregular sides, indicating only that these inclusions had undergone little change in the reheating. (Picral applied for 80 seconds; magnification, 50.)



Kamacite containing rhabdite inclusions in a parallel arrangement, Pittsburgh meteorite. (Magnification, 100.)



Coarse plessite surrounded by granulated kamacite, Pittsburgh meteorite. (Sodium picrate applied for 70 seconds; magnification, 100.)

A large cohenite with the characteristic kamacite inclusions, Pittsburgh meteorite. Above this cohenite there occurs an elongated plessite area, in one corner of which is a dark island of gamma-alpha iron; in the opposite upper corner there are some delicate acicular kamacite needles. The kamacitic groundmass is granular, and small dark grains are localized along the boundary of the kamacite. (Picral, 5 percent, applied for 130 seconds; magnification, 50.)

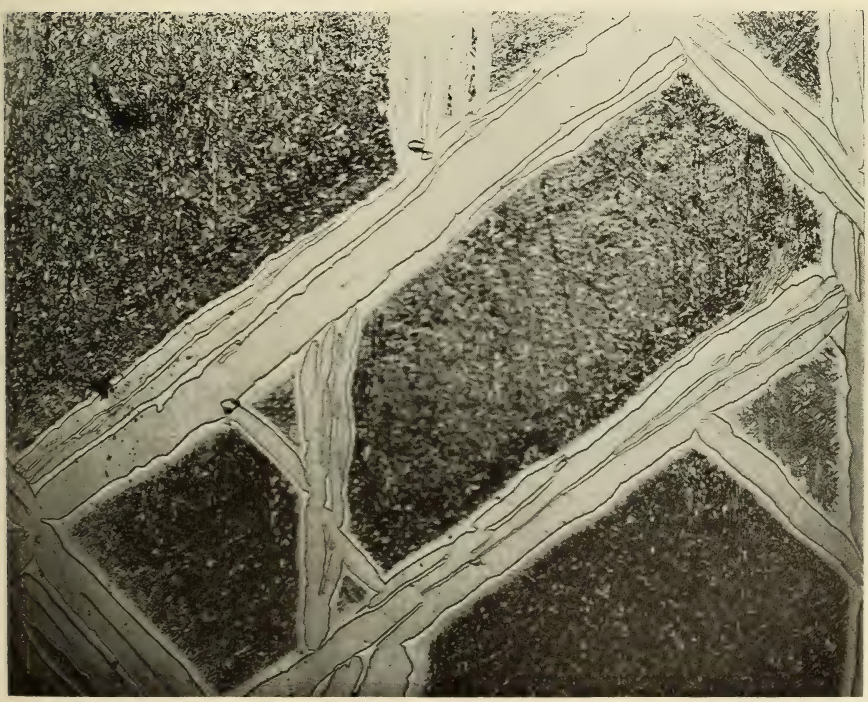
View of the Breece meteorite. Samples were taken from five of the long lathlike inclusions, Reichenbach lamellae, for X-ray, and in every case the film matched the lines on the standard schreibersite film. (Natural size.)

An etched cross section of the Tombigbee meteorite. Numerous irregular schreibersite bodies are dispersed in the matrix; the rhabdite inclusions are not shown. The areas selected for analysis are outlined. (Natural size.)

Explanation of Plate 18

The Soroti meteorite. Top.—Macrophotographs of two specimens taken in reflected light so that the plessite fields appear white. (Natural size.)

Bottom.—An area of fine octahedrite structure, the kamacite bands enclosing lamellae of taenite. Dense (imperfectly transformed) plessite in the interstices. (Picral, 4 percent, applied for 12 seconds; magnification, 50.)

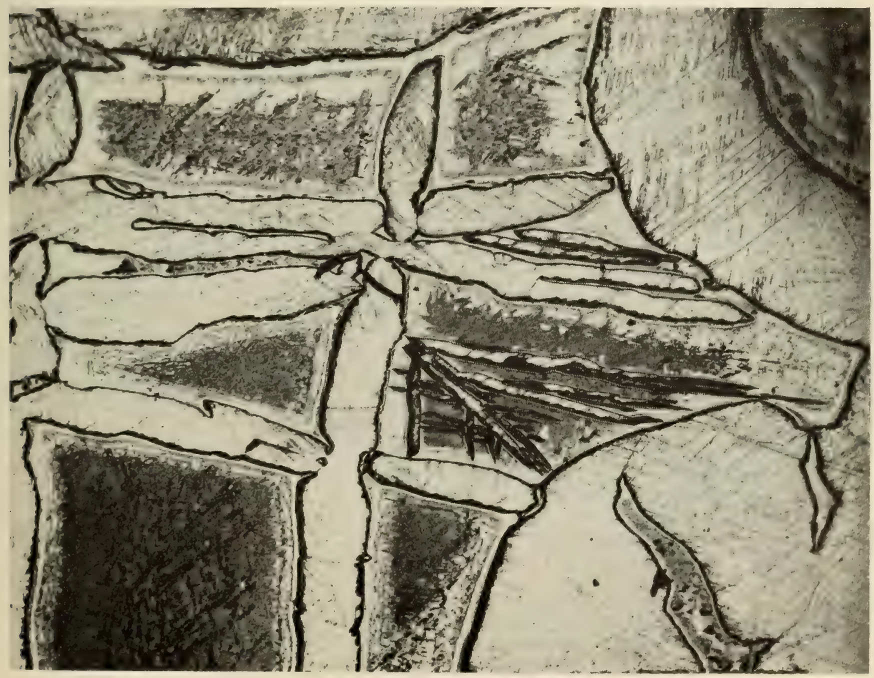


The Soroti meteorite. Explanation on facing page.

Explanation of Plate 19

The Soroti meteorite. Top.—The central inclusion with the dark spots is schreibersite, and it contacts a dark hexagonal body, troilite. The kamacite practically surrounding the schreibersite and extending downward to the lower right and left corners of the plate contains transformation structures. The large inclusion below the troilite and kamacite was not positively identified, but its chipped surface suggests schreibersite. The light area at the lower right also may be schreibersite. The dense plessite fields at the left, right, and top have lamellae of kamacite. (Picral 5 percent, applied for 40 seconds; magnification, 50.)

Bottom.—A plessite area with needles of kamacite. Much of the kamacite shows lines which may be transformation structures or Neumann lines. Transformation structures may simulate Neumann lines very closely. The dark area at the upper right corner is troilite. (Picral, 5 percent, applied for 40 seconds; magnification, 50.)



The Soroti meteorite. Explanation on facing page.

Explanation of Plate 20

The Keen Mountain meteorite. Top: Troilite is exposed on the bottom of the depression in the center of this face after about two millimeters of oxide were removed. The surface of the meteorite immediately surrounding this depression is partly corroded and some of the oxidization products rest on an unaltered fusion crust. The cuts, at the right end, were made by the finder before the object was identified. The slice used in the analysis (pl. 21, bottom) was cut along the line made by projecting A to A′. (About two-thirds natural size.)

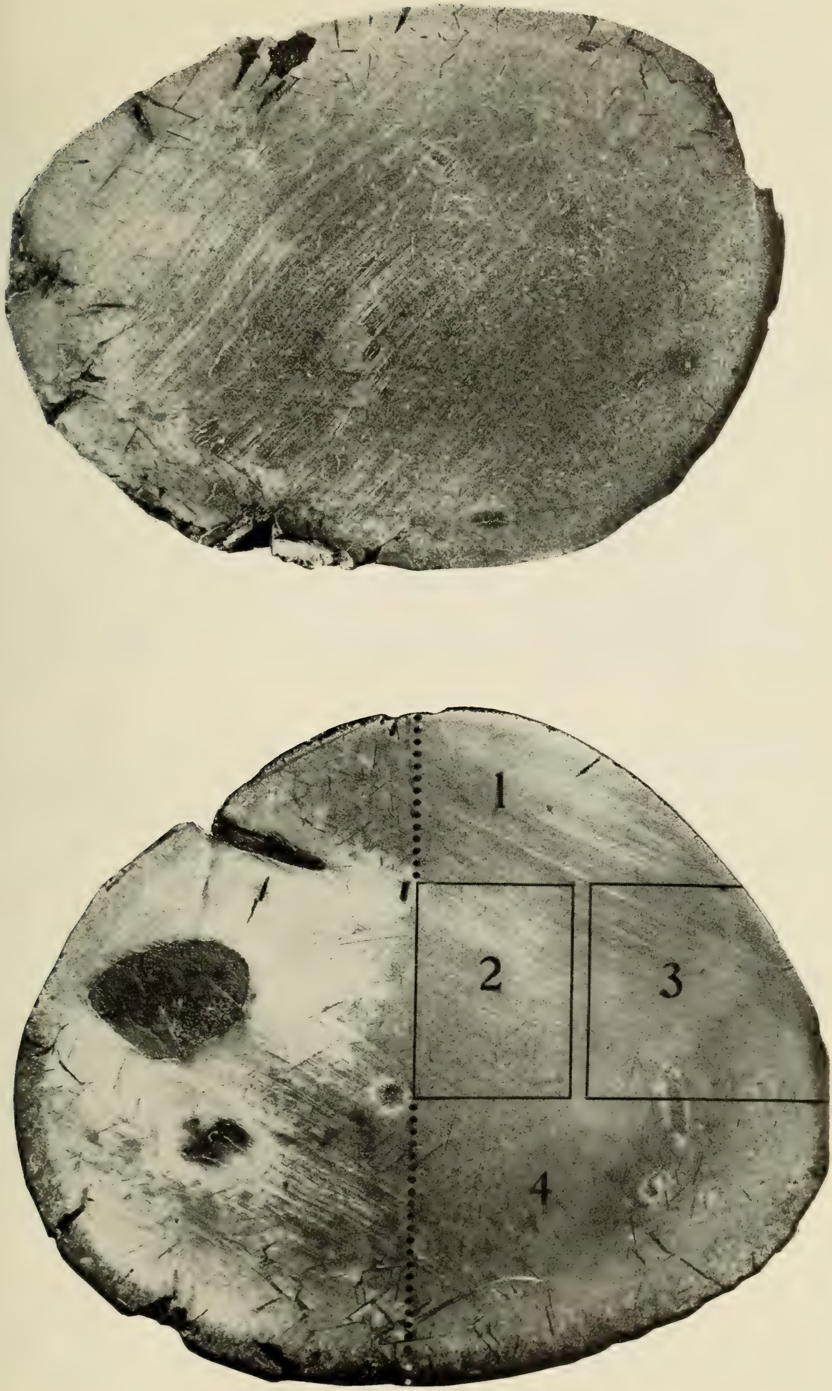
Bottom: This meteorite lacks the typical "thumbmark" depressions common to most iron meteorites. The shallow cavity at the lower right is surrounded with unaltered fusion crust in which flight markings are present. The file mark above the depression exposes fresh metal. The rougher surfaces represent corrosion. If the guide lines (at the sides and bottom of the picture) were projected they would cross over the spot believed to be the center of the forward face (stagnation point) during the fall of this meteorite. (Natural size.)

The Keen Mountain meteorite. Explanation on facing page.

Explanation of Plate 21

The Keen Mountain meteorite. Top.—The curved Neumann lines in the central portion end abruptly at the inner edge of the granulated zone. Sufficient heat was absorbed by this iron to granulate the metal from 7 to 9 millimeters in from the existing surface and to obliterate the Neumann lines. The fractures in the thermally altered zone possibly represent a volume adjustment made when the outside shell was reheated. The reheating and rapid cooling of the outside zone may have had something to do with the deformation of the Neumann lines and the displacement of the phosphide lamellae shown in plate 22 (bottom). (Magnification, 1.2.)

Bottom.—This thin slice was removed about 15 millimeters further into the meteorite than the slice pictured at top, and the thermally granulated zone around the edges is not as wide as the zone shown in that slice. The Neumann lines in the center are slightly deformed. This slice was cut along the dotted lines and the density of sections 1–3 was determined. The analysis was made on section No. 2. (Magnification, 1.3.)

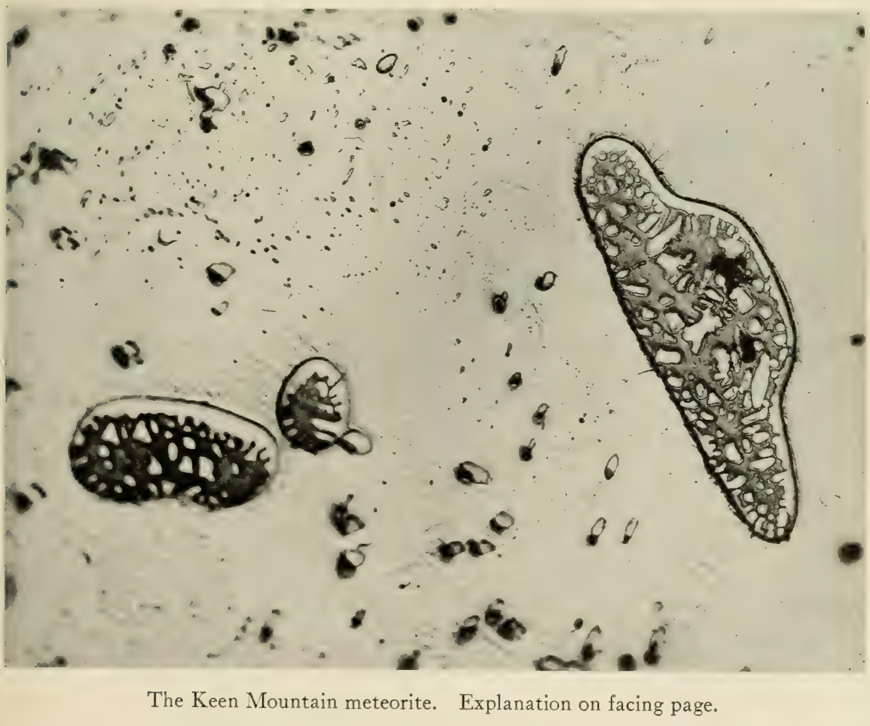


The Keen Mountain Meteorite. Explanation on facing page.

Explanation of Plate 22

The Keen Mountain meteorite. Top.—A group of phosphide particles with their pointed ends lying in the same direction and separated by channels of kamacitic iron. This habit suggests that these phosphides reacted with the matrix. The phosphide in the lamella at the left is broken into small segments but the particles are not separated very far. There are many such lamellae in this slice. Fewer rhabdites occur in the kamacite immediately adjacent to these long lamellae than are found in the kamacite some distance away. Many of these long lamellae are not straight and we assume that they have been deformed by movement of the kamacitic matrix. (Magnification, 150.)

Bottom.—These inclusions indicate Fe-Fe_3P eutectic structures which formed by reheating. The rhabdite lost its original form and became rounded. This eutectic inclusion could be formed by melting but possibly these bodies never became liquid. After their reheating, they cooled so fast that the excess iron could not migrate beyond the limits of the inclusion. (Magnification, 150.)



The Keen Mountain meteorite. Explanation on facing page.

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NEW NEOTROPICAL WASPS OF THE FAMILY BRACONIDAE (HYMENOPTERA) IN THE U. S. NATIONAL MUSEUM

By C. F. W. Muesebeck [1]

The parasitic Hymenoptera of the Neotropical region are still mostly undescribed; accordingly it is not possible to give specific names for the majority of samples that are received for identification. In the Braconidae alone a very considerable number of new species from Neotropical localities have accumulated in the collections of the U. S. National Museum, most of them received from workers interested in the biological control of various insect pests. For some of these new species, names have been wanted for a rather long time. Finally, a beginning is being made on the task of naming and describing them. For the present paper I have selected forms that, because of their host associations or distribution or because they add significantly to our understanding of the superspecific groups involved, are of more than usual interest. Unfortunately, it is not at present feasible, or possible, to include workable keys to the Neotropical species of such

[1] U. S. Department of Agriculture, Entomology Research Branch, Insect Identification and Parasite Introduction Section.

large genera as *Apanteles*, *Opius*, and *Meteorus*, but for a few small groups this has been done. In addition, two new genera are described and some new synonymy and new combinations are indicated.

For the drawings I am indebted to Mr. R. A. Cushman, artist of the Entomology Research Branch, U. S. Department of Agriculture.

Genus *Microctonus* Wesmael

The species of this genus often have been assigned erroneously to *Perilitus* Nees, and the single known South American species identifiable as a *Microctonus* was described by Szepligeti as *Perilitus brasiliensis*. It appears to be closely similar superficially to the second of the two new species described here.

Microctonus brasiliensis (Szepligeti), new combination

Perilitus brasiliensis Szepligeti, Termes. Fuzetek, vol. 25, p. 80, 1902.

This species was described from a single male from Brazil in the collection of the Hungarian National Museum.

Microctonus audax, new species

FIGURES 1,*k*; 4,*e*

This new species is distinguished from the other known South American species by its large eyes, short malar space, and evenly rugulose, nonareolate propodeum.

FEMALE: Length about 3 mm. Head broader than thorax; face broader than long, minutely punctate; eye longer than narrowest width of face; clypeus punctate, twice as long as malar space, its base defined by a sharply impressed line; frons, vertex, and temples smooth and shining; a dimple-like impression between posterior ocelli; antennae usually 30- to 33-segmented, about as long as body.

Mesoscutum smooth and shining; notaulices foveolate and meeting behind in a rugose area that is divided by a median longitudinal carina; median lobe with short, sparse pubescence; lateral lobes bare; scutellum strongly convex, impunctate, polished; propodeum uniformly closely rugose, without prominent carinae, its posterior face vertical and conspicuously hollowed out in the middle; mesosternal groove coarsely foveate; mesopleuron smooth and shining above, extensively rugulose punctate below; radial cell on wing margin nearly as long as stigma; lower abscissa of basella shorter than nervellus.

Abdomen at widest point much narrower than thorax; first tergite more than twice as long as broad at apex, the petiole polished, the expanded portion finely aciculate; remainder of abdomen polished; ovipositor sheath a little shorter than hind femur.

Head black; temples, cheeks and mandibles more or less brown; antennae dark brown to black; thorax black, sometimes reddish brown

on sides and below; legs including all coxae reddish brown; wings hyaline, stigma yellowish, margined with brown; abdomen reddish brown, first tergite more or less blackish.

MALE: Like the female but usually somewhat darker in color, with thorax entirely black, abdomen mostly piceous, posterior coxae darkened at bases, hind tibiae and tarsi more or less darkened, sometimes all tarsi dark; also the antennae longer than the body, normally 34- to 36-segmented; face broader than eye height; malar space two-thirds as long as clypeus.

TYPE: USNM 63044.

TYPE LOCALITY: Santa Fé, Argentina.

Described from 8 females and 8 males reared from adult weevils of the genus *Listroderes* by H. L. Parker in October 1944. According to Dr. Parker the female has the remarkable habit of ovipositing in the host weevil through the mouth.

Microctonus berryi, new species

This new species apparently is very similar to *Microctonus brasiliensis* (Szepligeti) but smaller, and is further distinguished by the somewhat shorter antennae, yellow scapes, and reticulate propodeum.

FEMALE: Length about 2.5 mm. Head slightly broader than thorax; face at least 1½ times as broad as long, not distinctly punctate, covered with very short pile; clypeus slightly longer than malar space; frons, vertex, and temples smooth and polished; antennae with about 24 segments.

Mesoscutum smooth and shining; lateral lobes bare; surface of middle lobe with short pubescence; notaulices sharply impressed, foveolate, meeting at posterior margin of mesoscutum; a short median keel extending forward from point of union of notaulices; scutellum slightly convex, impunctate; dorsal face of propodeum reticulate, with two large, transverse, nearly smooth areas at base, posterior face rugulose, excavated in the middle; mesosternal groove finely foveolate; mesopleuron smooth and polished, sometimes with a few coarse punctures below; venation essentially like that of *M. audax;* radial cell on wing margin two-thirds as long as stigma; first abscissa of radius less than half as long as width of stigma; lower abscissa of basella and nervellus subequal.

Abdomen at widest point only slightly narrower than thorax; first tergite much more than twice as long as broad on caudal margin, smooth and polished on basal third, usually striate beyond; remainder of abdomen polished; ovipositor sheath fully as long as hind femur.

Head yellow, with a small blackish spot enclosing ocelli; antennal flagellum brown, paler toward base beneath; scape reddish yellow; dorsum of thorax including propodeum blackish, with scutellum

and areas bounding notaulices reddish; pleura and sternum reddish yellow; wings hyaline, stigma yellowish bordered with brown; legs reddish yellow, all tarsi and posterior tibiae fuscous to blackish; abdomen yellowish brown, first tergite piceous except at base where it is yellowish.

Male: Differs from the female in the slightly longer antennae, which have around 26 segments, in having the thorax black except for the yellowish prothorax and reddish mesopleura, in the nearly smooth first tergite, and in having the second and following tergites piceous.

Type: USNM 63045.

Type locality: Angol, Chile.

Described from 11 females and 7 males reared by Paul A. Berry from a chrysomelid on willow, Mar. 9, 1941, at Angol, Chile; 2 females and 1 male reared by L. Duran from adults of the chrysomelid *Plagiodera erythroptera* (Blanchard), October 1940, at Panquehue, Chile; and 1 female reared by H. L. Parker from the same host at Angol, Chile, Feb. 22, 1941.

Genus *Meteorus* Haliday

Meteorus eaclidis, new species

Figures 1,*i*; 2,*b*

This new species is closely similar to *townsendi* Muesebeck but distinguished by having the middle lobe of mesoscutum convex rather than shallowly impressed, by the relatively wider cubitellan cell, by the paler tegulae, and by the noninterstitial recurrent vein. Moreover, the cocoons of this species are formed singly whereas those of *M. townsendi* are arranged in a compact mass that is encased in loose silk.

Female: Length about 4 mm. Head a little wider than thorax, smooth; temples gradually receding; occipital carina narrowly interrupted at middle; face 1½ times as broad as long; malar space longer than basal width of mandible; ocellocular line about twice the diameter of an ocellus; antennae a little longer than body, usually 30- to 32-segmented.

Thorax stout; notaulices sharply impressed; middle lobe of mesoscutum convex, not impressed down middle, weakly punctate; scutellum convex, polished, 1½ times as long as the large bifoveate sulcus at its base; propodeum coarsely rugose-reticulate, the posterior declivity deeply excavated medially; side of pronotum smooth and shining except for the median depression, which is crossed by a few strong rugae; mesopleuron mostly smooth but with the broad longitudinal impression coarsely rugose; hind coxae punctate; longer calcarium of hind tibia about as long as second segment of hind tarsus;

radius issuing from beyond middle of stigma; first abscissa of radius as long as, or longer than, second, the latter about half as long as second intercubitus; radial cell nearly attaining extreme apex of wing; recurrent vein joining first cubital cell; lower abscissa of basella longer than nervellus; cubitellan cell at narrowest point at least 1½ times as wide as greatest width of radiellan cell.

Abdomen a little narrower than thorax; first tergite without dorsal fossae, finely, closely aciculate except at base, the ventral margins joined from base to postpetiole; ovipositor sheath shorter than hind tibia.

Honey yellow; palpi paler; antennae black; tegulae brownish yellow, blackish on outer margins; wings noticeably infumated; stigma and veins dark brown; hind tibia black apically; hind tarsus fuscous, basal half of metatarsus pale.

Male: Differs in no significant details from the female.

Type: USNM 63046.

Type locality: São Paulo, Brazil.

Described from four females and one male reared from *Eacles magnifica* Walker by E. J. Hambleton at the type locality June 10, 1935, and 18 females and 11 males reared from an unidentified lepidopterous larva at Tiete, São Paulo, Brazil, in February 1939 by M. Antonio and submitted by L. O. T. Mendes.

Meteorus kraussi, new species

Figures 3,*d*,*i*

This species immediately suggests *M. vulgaris* (Cresson), but the ventral margins of the first tergite are closely joined from the base to the postpetiole; the postpetiole is more coarsely sculptured, and the malar space is much longer than in *M. vulgaris*.

Female: Length about 3.5 mm. Face very finely roughened, subopaque, at its narrowest point fully as wide as length of eye; malar space distinctly longer than basal width of mandible; vertex and temples polished; temple convex, three-fourths as wide as eye; ocell-ocular line more than twice as long as greatest diameter of an ocellus; antennae a little longer than body, 26- to 28-segmented.

Mesoscutum shining, shallowly punctate, the lateral lobes very weakly so; propodeum coarsely reticulately sculptured; 1st abscissa of radius usually about as long as 2d; recurrent vein interstitial with first intercubitus; nervulus slightly postfurcal; lower abscissa of basella much longer than nervellus; legs very slender.

First tergite without dorsal fossae; ventral margins of petiole closely joined throughout; postpetiole closely longitudinally striate; ovipositor

sheath a little shorter than abdomen; ovipositor greatly thickened toward base, as in *M. vulgaris*.

Honey yellow; antennae more or less brownish; postpetiole a little darkened, at least laterally; wings hyaline, stigma hyaline, margined with brown; legs brownish yellow, hind tibiae and tarsi weakly infuscated.

Male: Like the female in essential details.

Type: USNM 63047.

Type locality: Cuernavaca, Mexico.

Described from 23 females and 3 males reared by N. L. H. Krauss Aug. 28, 1944, from a lepidopterous larva on *Eupatorium adenophorum*. Another series of 16 females and 1 male is labeled "Cuernavaca, Mex., Nov. 1944, N. L. H. Krauss," without further data. As in the case of *M. vulgaris*, a number of individuals develop in a single host caterpillar.

Genus *Centistes* Haliday

The genus *Leiophron* was proposed by Nees in 1818 (Nova Acta Acad. Caes. Leop. Carol., vol. 9, p. 303). He showed that he was basing the genus on three species but, unfortunately, he did not name or describe any of them in that paper. All three were described in 1834 (Hymenopterorum ichneumonibus affinium, Monographie, vol. 1, pp. 44, 45) when Nees treated the genus in more detail. In the meantime, however, Haliday (Ent. Mag., vol. 1, pp. 263, 264, April 1833) had placed three new species in *Leiophron*, describing them very briefly in a key, and Curtis (British Entomology, vol. 10, p. 476, November 1833) had included nine, one of which, *pallipes* Curtis, he had designated as type. In 1839 Westwood (Introduction to the modern classification of insects, vol. 2, Synopsis p. 62) selected *ater* Nees as type of *Leiophron*, which permitted use of the generic name in its original sense, and that concept has been generally adopted. However, recently the International Commission on Zoological Nomenclature (Bull. Zool. Nom., vol. 4, pp. 130, 346, 1950) has declared that in the case of generic names proposed before January 1, 1931, without originally included species, only those species which are first referred to such a genus after publication of the name may be considered eligible for type selection. Accordingly, Viereck's designation of *Leiophron apicalis* (Curtis) Haliday (U. S. Nat. Mus. Bull. 83, p. 83, 1914) must be accepted as the first valid designation; and since *L. apicalis* is considered to be congeneric with the type of *Euphorus* Nees, this generic name must be suppressed as a synonym of *Leiophron*. For *Leiophron* of Authors it seems to be necessary to use *Centistes* Haliday, the synonymy of which is as follows:

Ancylus Haliday, Ent. Mag., vol. 1, p. 261, 1833. Preoccupied by *Ancylus* Mueller, 1774, in Mollusca. Type, *A. cuspidatus* Haliday, by designation of Viereck, U. S. Nat. Mus. Bull. 83, p. 10, 1914.

Centistes Haliday, Ent. Mag., vol. 2, pp. 459, 462, 1835. Type, *Ancylus cuspidatus* Haliday, by monotypy.

Ancylocentrus Foerster, Verh. Naturh. Ver. Preuss. Rhienl., vol. 19, p. 254, 1862. Type, *Ancylus excrucians* Haliday, by monotypy.

Euphoridea Ashmead, Proc. U. S. Nat. Mus., vol. 23, p. 116, 1900. Type, *Euphoridea claripennis* Ashmead, by monotypy and original designation.

Liosigalphus Ashmead, Proc. U. S. Nat. Mus., vol. 23, p. 125, 1900. Type, *Liosigalphus politus* Ashmead, by monotypy and original designation.

Pygostolus Haliday, 1833, was proposed as a subgenus of *Leiophron*; It is, however, quite distinct from that genus, being, in fact, properly placed in the Blacinae rather than in the Euphorinae; but although it is very closely related to *Centistes* (which it antedates), I consider it generically distinct. It differs most conspicuoulsy in the long ovipositor sheath, which is half as long as the abdomen, in the presence of a basal median plate on the first tergite, which is defined by carinae that converge caudad, and by having the radius going to the extreme apex of the wing.

Centistes epicaeri, new species

FIGURES 1,*l*; 3,*a*

This is apparently the first species of the genus to be recorded from the Neotropical region. It is very similar to the European *C. lituratus* (Haliday) but may be distinguished at once by the lack of a ventral tooth near the apex of the hind coxa. From *C. edentatus* (Haliday), another European species, it differs especially in its much larger and virtually parallel-sided first tergite.

FEMALE: Length about 3 mm. Head strongly transverse; temples receding; frons and vertex polished; face slightly broader than long, with minute and faint punctures; malar space not quite as long as clypeus; antennae filiform, about as long as body, usually 30-segmented; ocellocular line very slightly longer than greatest diameter of an ocellus; occiput completely carinately margined.

Mesoscutum shining; notaulices shallow but distinct, meeting well before posterior margin of mesoscutum; mesonotal lobes faintly punctate anteriorly; scutellum smooth, convex; propodeum basally with two very weak, irregular, slightly divergent, median longitudinal carinae, each extending to posterior declivity and there leading into a tranverse carina that extends to the lateral margin; the two large basal areas of propodeum smooth basally toward middle, finely punctate-rugulose laterally and posteriorly; posterior declivity gradual, rugulose; mesopleuron with a long, finely foveolate, longitudinal furrow; wing venation as illustrated.

Abdomen narrower than thorax; first tergite at spiracles fully half as wide as propodeum is wide at base, parallel-sided from spiracles to apex and closely, finely striate; remaining tergites smooth and polished; ovipositor sheath and ovipositor as illustrated.

Black; lower half of clypeus, mandibles, and antennae, basally below, dark brown; legs uniformally brownish yellow except for hind coxae, which are blackish toward bases; wings hyaline, stigma dark brown.

Male: Unknown.

Type: USNM 63048.

Type locality: Santa Ana, El Salvador.

Described from 114 female specimens reared by Paul A. Berry in 1951 from *Epicaerus capetillensis* Sharp, a curculionid on coffee.

Genus *Leiophron* Nees

Leiophron Nees, Nova Acta Acad. Leop. Carol., vol. 9, p. 303, 1818. No species.
Leiophron Nees, Haliday, Ent. Mag., vol. 1, p. 263, 1833. Three species. Type, *L. apicalis* (Curtis) Haliday, by designation of Viereck, 1914.
Euphorus Nees, Hymenopterorum ichneumonibus affinium, Monographie, vol. 2, p. 360, 1834. Type, *E. pallicornis* Nees, by monotypy. New synonymy.

As pointed out in the foregoing discussion under *Centistes*, the type of *Euphorus* is congeneric with the species which must be accepted as type of *Leiophron* under a recent ruling of the International Commission on Zoological Nomenclature. Accordingly, *Euphorus* must be suppressed as a synonym of *Leiophron*.

Genus *Microgaster* Latreille

Five species are now known from the Neotropical region that belong in that section of the genus *Microgaster* in which (1) the habitus is that of *Apanteles*, (2) the propodeum lacks a median longitudinal carina and has, instead, a more or less distinct areola, (3) the mesoscutum is covered with shallow, separated punctures, and (4) the second cubital cell is minute, with the second intercubitas hyaline and arising from the first intercubitus rather than from the end of the first abscissa of radius. After more is known about this group it may prove advisable to set it off as a separate genus. For the present it seems best to keep it in *Microgaster*.

The structural differences between the five Neotropical species are rather subtle and not easily defined, but the following color key will distinguish these forms.

1. Thorax black 2
   At least mesoscutum testaceous 3
2. Hind coxa black, at least on basal half; abdomen black, with second and third tergites sometimes testaceous . . . . **ecdytolophae** Muesebeck
   Hind coxa entirely reddish yellow; abdomen reddish yellow, with apical tergites usually black or blackish . . . . **jocarae,** new species

3. Thorax entirely testaceous; abdomen testaceous except at apex. **imitator** (Ashmead)
   At least propodeum black; first tergite black or piceous 4
4. Wings somewhat smoky . . . . **blanchardi,** new name
   Wings clear hyaline, iridescent . . . . **diaphaniae,** new species

Microgaster ecdytolophae Muesebeck

Microgaster ecdytolophae Muesebeck, Proc. U. S. Nat. Mus., vol. 61, Art. 16, pp. 21, 24, 1922.

This species, which is widely distributed in the Nearctic region where it occurs from Nova Scotia to Texas, has also been reared in Cuba from *Hippia insularis* (Grote) and in Guatemala from *Rhobondo guarisana* Walker.

Microgaster jocarae, new species

This new species is very similar to *M. diaphaniae* but with the thorax black and the abdomen pale yellow except for blackish median spots on the fourth and following tergites.

Female: Length about 3 mm. Face closely punctate and subopaque; clypeus slightly longer than malar space, punctate; vertex and temples punctate and rather dull; frons weakly punctate toward sides and directly below ocelli; head abruptly declivous behind ocelli; occiput polished, impunctate; antennae about as long as the body.

Mesoscutum more densely punctate than in *M. diaphaniae* and less shining, the punctures larger and almost or quite contiguous; disc of scutellum polished, with only a few scattered, weak punctures; polished area on lateral face of scutellum large, broadly triangular; propodeum finely rugulose, with a fairly well defined, more or less pentagonal areola, and weakly delimited, largely smooth and shining, apical lateral areas; mesopleuron polished but with sharp punctures anteriorly and below as well as a few in upper posterior angle; metapleuron polished except at posterior margin where it is rugulose; hind coxa with an elongate, flattened, finely rugulose area on dorsal edge toward base, punctate on outer face; inner calcarium of hind tibia much longer than outer and more than half as long as metatarsus; stigma short and broad, shorter than metacarpus, emitting radius from beyond its middle; first abscissa of radius arched and joining first intercubitus in an even curve; second intercubitus very short, inconspicuous; second cubital cell minute; nervellus nearly straight and nearly perpendicular to anterior margin of wing.

Abdomen much narrower than thorax; first tergite broadening very slightly caudad, longer than broad, smooth and shining except for a few scattered punctures on posterior half; second and following tergites smooth and polished, the plate of the second three times as broad on posterior margin as long and defined laterally by oblique grooves,

its posterior margin arcuate; ovipositor sheath slender but broadening gradually to near apex, about as long as hind tibia.

Head and thorax black; clypeus, labrum, mandibles, and palpi yellow; scape yellow with a dark streak outwardly toward the front; flagellum dark brown; tegulae and wing bases yellowish white; wings hyaline, stigma and most of veins brown, second intercubitus hyaline; anterior and middle legs entirely yellow; posterior leg yellow except apex of femur, apical two-fifths or more of tibia, and tarsus, which are black; abdomen entirely yellow above and below except for median blotches on fourth and following tergites which are sometimes joined to form a median dark streak.

MALE: Like the female but with the apical abdominal tergites more extensively black.

TYPE: USNM 63049.

TYPE LOCALITY: Santiago de las Vegas, Cuba.

Described from four females and three males reared by A. Otero from the larva of *Jocara ferrifusalis* Hampson. The U. S. National Museum has, in addition, nine males of the same species reared from *Pilocrosis inguinalis* Guenée, at Cayey, Puerto Rico, Jan. 7, 1941, by L. F. Martorell.

Microgaster imitator (Ashmead)

Urogaster imitator Ashmead, Trans. Ent. Soc. London, 1900, pt. 2, p. 288, 1900.
Microgaster imitator (Ashmead), Wilkinson, Bull. Ent. Research, vol. 21, p. 157, 1930.

This species is known only from the unique type, described from St. Vincent, which is in the British Museum.

Microgaster blanchardi, new name

Apanteles areolaris Blanchard, Arthropoda, vol. 1, No. 1, p. 6, 1947.

Although this species belongs in a group whose members have the habitus of *Apanteles*, it falls in *Microgaster* as that genus is currently defined. With its transfer to *Microgaster* the specific name needs to be changed, since it is preoccupied by *Microgaster areolaris* Thomson, 1895.

The species is known to me only from the original description. Apparently the type is the only known specimen. It is recorded as having been reared from an unidentified larva of Gelechiidae on *Solanum bonariensis* in Buenos Aires, Argentina.

Microgaster diaphaniae, new species

This new species is exceedingly similar to *M. blanchardi* Muesebeck, which I know only from the original description, but apparently it may be distinguished by its clear hyaline, iridescent wings. In *M. blanchardi* the wings are said to be a little smoky.

Female: Length about 3 mm. Face much broader than long, closely punctate and subopaque; malar space slightly shorter than clypeus; temple narrow, rounded, punctate; head evenly hollowed out behind, descending vertically directly behind the ocelli; antennae about as long as the body.

Mesoscutum shining, with sharp, but shallow, separated punctures, those on posterior half being more than a puncture's width apart; prescutellar furrow finely foveolate; disc of scutellum flat, impunctate, polished; polished area on lateral face of scutellum large, triangular; propodeum weakly rugulose at base, and with a rather well defined areola and large apical lateral areas that are smooth and shining; mesopleuron smooth and shining except for well-separated punctures anteriorly and below; metapleuron polished; hind coxa smooth and shining except on dorsal edge which is finely rugulose; inner calcarium of hind tibia much longer than outer and more than half as long as metatarsus; first abscissa of radius slightly arched, much longer than first intercubitus; second cubital cell minute; second intercubitus very weak; nervellus straight.

Abdomen slender; plate of first tergite broadening very slightly caudad, much longer than broad at apex, and with a few large, scattered punctures on caudal half; second tergite much shorter than third, smooth and polished, the median plate set off by lateral, oblique grooves; remainder of abdomen smooth and polished; ovipositor sheath slender but broadening gradually apically, about as long as hind tibia.

Head black; clypeus, labrum, mandibles, and scape except for a dark blotch outwardly, reddish yellow; antennal flagellum dark brown; thorax black except prothorax and mesonotum which are testaceous or reddish; tegulae and wing bases pale yellow; wings hyaline, costa, stigma and most of the veins brown; anterior and middle legs entirely yellow, posterior leg yellow except femur at apex, apical two-fifths or more of tibia and the tarsus, which are blackish; abdomen black, sometimes third tergite more or less reddish toward apex, and occasionally third and fourth tergites largely reddish.

Male: Like the female except that the mesoscutum tends to be dark red rather than testaceous.

Type: USNM 63050.

Type locality: San Pedro de Montes de Oca, Costa Rica.

Described from 2 females and 8 males reared from *Diaphania nitidalis* (Stoll), February 1935, by C. H. Ballou; 5 females from La Ceiba, El Salvador, received from Vera Wellborn; and 8 females and 2 males (most of the specimens headless) collected by J. Camelo-G. at Tuxtepec, Oaxaca, Mexico, in June 1934. The U. S. National

Museum also has 4 female specimens reared from *D. nitidalis* in Federal District, Brazil, July 1945, by C. R. Gonçalves, that differ from the material from Central America and Mexico in having the scutellum testaceous. Structurally all are essentially the same and I do not believe that even subspecific rank for the Brazilian specimens is warranted.

Genus *Promicrogaster* Brues and Richardson

Promicrogaster Brues and Richardson, Bull. Amer. Mus. Nat. Hist., vol. 32, p. 499, 1913. Type, *P. terebrator* Brues and Richardson, by monotypy and original designation.

This genus is very similar to *Microgaster* Latreille, and when more species are known it may prove to be untenable. For the present, however, it seems best to recognize it as a separate genus distinguished from *Microgaster* by the following combination of characters: Head very thin, the temples strongly receding; clypeus not separated from face; labium protruding conspicuously and deeply bifurcate at apex; areolet of forewing minute; longer calcarium of hind tibia not more, usually less, than half as long as metatarsus; disc of scutellum longer than broad, the polished area each side of disc occupying nearly all of lateral face; hypopygium large, plowshare-like; ovipositor sheath much longer than abdomen. Distribution, Neotropical.

Key to the known species of *Promicrogaster*

1. Propodeum with a prominent median longitudinal carina; first tergite not narrowing caudad, smooth and shining; malar space at least half as long as eye; length about 6 mm. 2
   Propodeum without a median carina; first tergite narrowing caudad and rugulose or coarsely punctate on apical half; malar space much shorter; length usually 4 to 5 mm. 3
2. Middle and hind legs beyond coxae largely black.
   terebrator Brues and Richardson
   Legs reddish yellow . . . . **miranda,** new species
3. Abdomen largely reddish yellow above and entirely so below; hind coxae not black basally; length about 5 mm. . . . . **munda,** new species
   Abdomen black, the third and following segments narrowly white on posterior margins; hind coxae black basally; length not over 4 mm.
   polyporicola, new species

Promicrogaster terebrator Brues and Richardson

Promicrogaster terebrator Brues and Richardson, Bull. Amer. Mus. Nat. Hist., vol. 32, p. 500, 1913.

This species is known from a single specimen collected at Chenopowu, British Guiana. It is apparently exceedingly similar to *P. miranda,* from which it differs most conspicuously in the color of the legs, the middle and hind legs beyond the coxae being black.

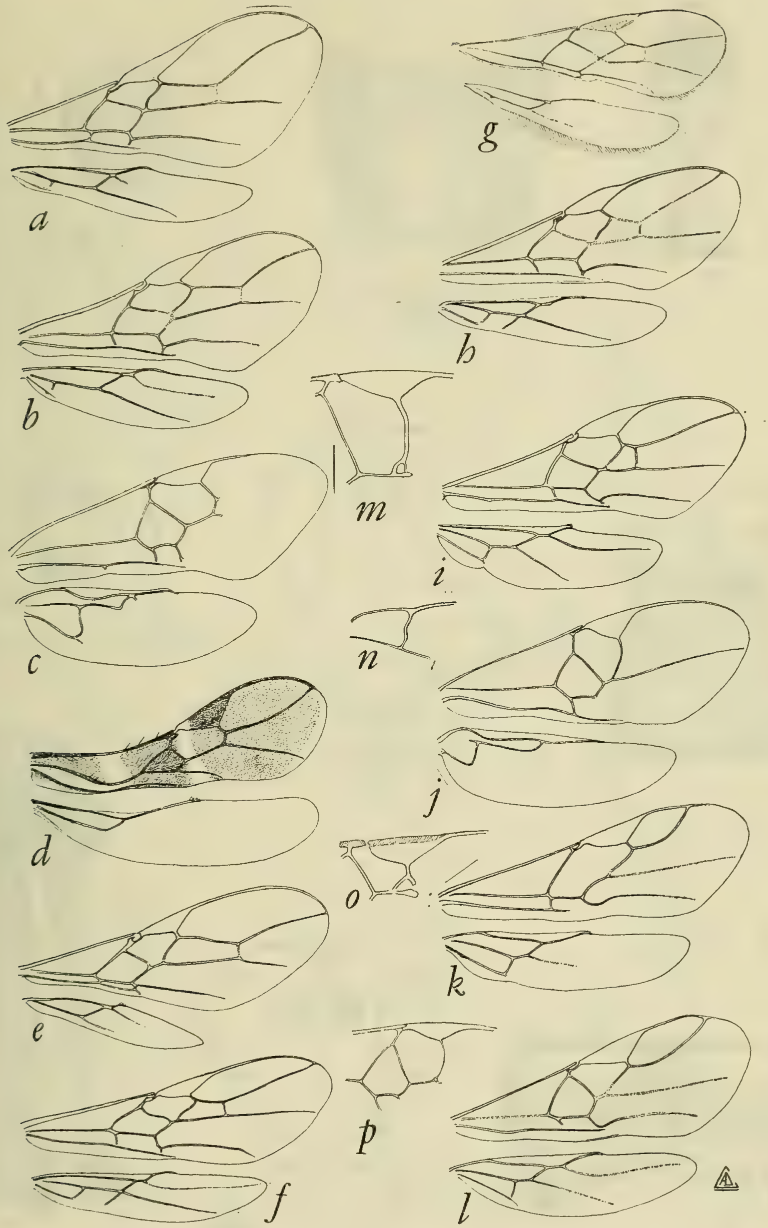

FIGURE 1.—*a–l*, Anterior and posterior wings of: *a*, *Opius aldrichi*, new species; *b*, *O. divergens*, new species, *c*, *Fornicia balloui*, new species; *d*, *Percnobracon secundus*, new species; *e*, *Phaenocarpa anastrephae*, new species; *f*, *Opius toxotrypanae*, new species; *g*, *Leurinion primum*, new species; *h*, *Opius capsicola*, new species; *i*, *Meteorus eaclidis*, new species; *j*, *Apanteles coffeellae*, new species; *k*, *Microctonus audax*, new species; *l*, *Centistes epicaeri*, new species. *m*, *n*, *Dasylagon aegeriae*, new species: *m*, stigma and first and second cubital cells; *n*, nervellus. *o*, *Microplitis minutalis*, new species: stigma and first and second cubital cells. *p*, *Promicrogaster miranda*, new species: portion of anterior wing.

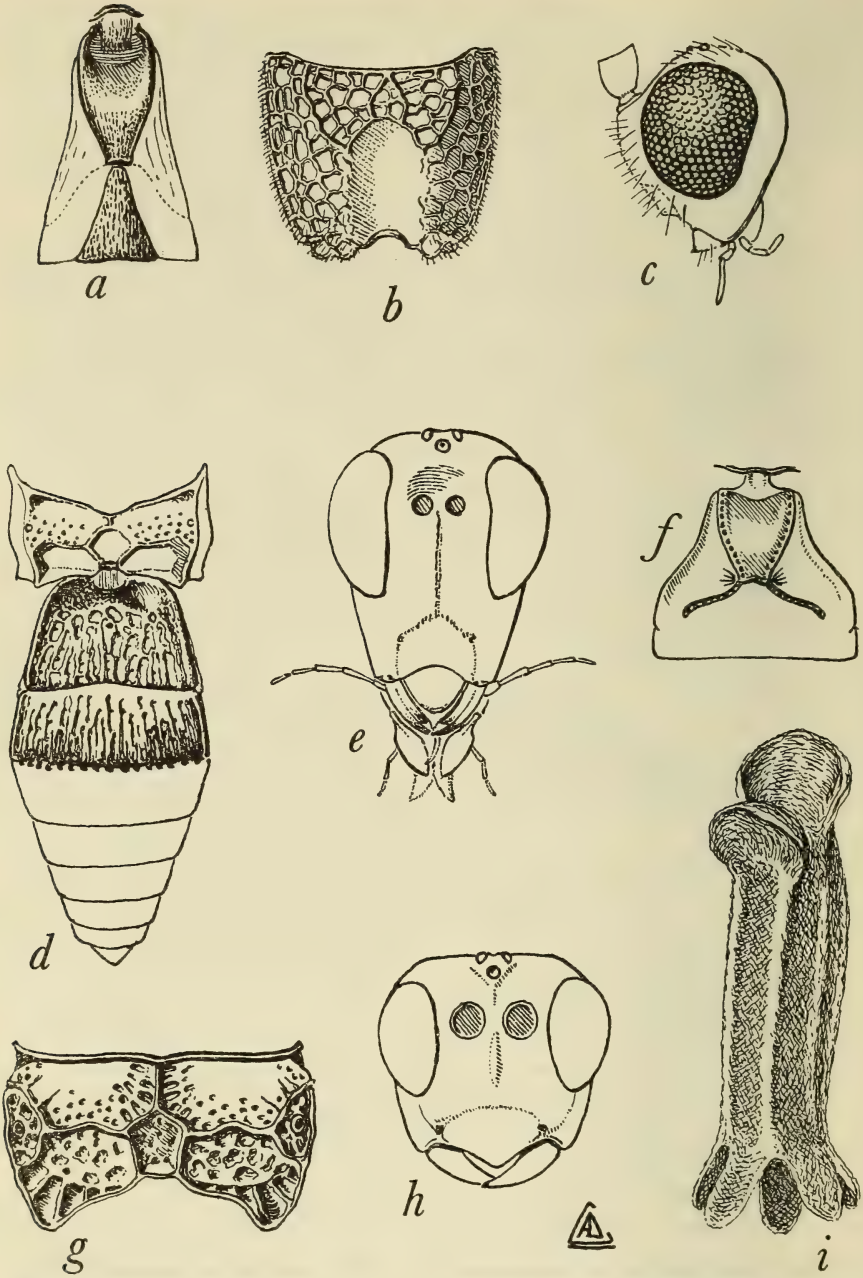

FIGURE 2.—*a*, First and second tergites of *Apanteles concinnus*, new species; *b*, propodeum of *Meteorus eaclidis*, new species; *c*, lateral view of head of *Leurinion primum*, new species; *d*, propodeum and abdomen of *Apanteles paradoxus*, new species; *e*, front view of head of *Promicrogaster miranda*, new species; *f*, first and second tergites of *Apanteles coffeellae*, new species; *g*, propodeum of *Dasylagon aegeriae*, new species; *h*, front view of head of *Opius toxotrypanae*, new species; *i*, cocoon of *Apanteles concinnus*, new species.

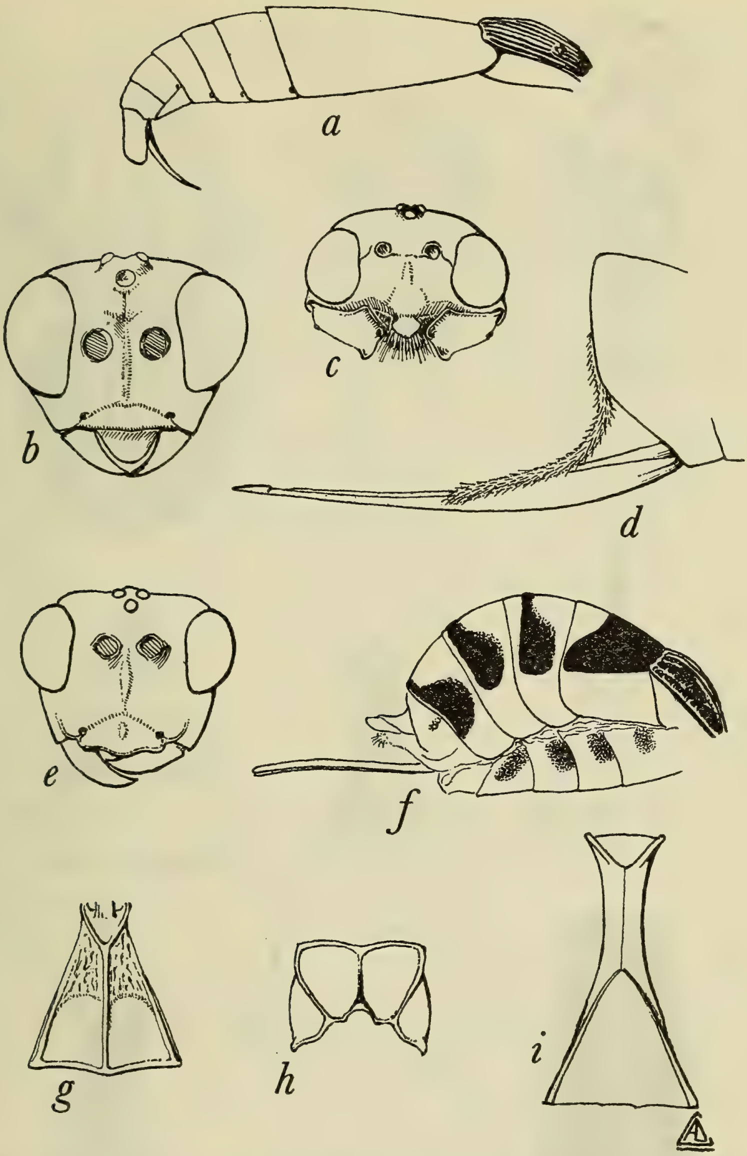

Figure 3.—*a*, Lateral view of abdomen of *Centistes epicaeri*, new species; *b*, front view of head of *Opius divergens*, new species; *c*, front view of head of *Phaenocarpa anastrephae*, new species; *d*, ovipositor of *Meteorus kraussi*, new species; *e*, front view of head of *Opius capsicola*, new species; *f*, lateral view of abdomen of *Opius aldrichi*, new species; *g*, first tergite and, *h*, propodeum of *Leurinion primum*, new species; *i*, ventral view of first abdominal segment of *Meteorus kraussi*, new species.

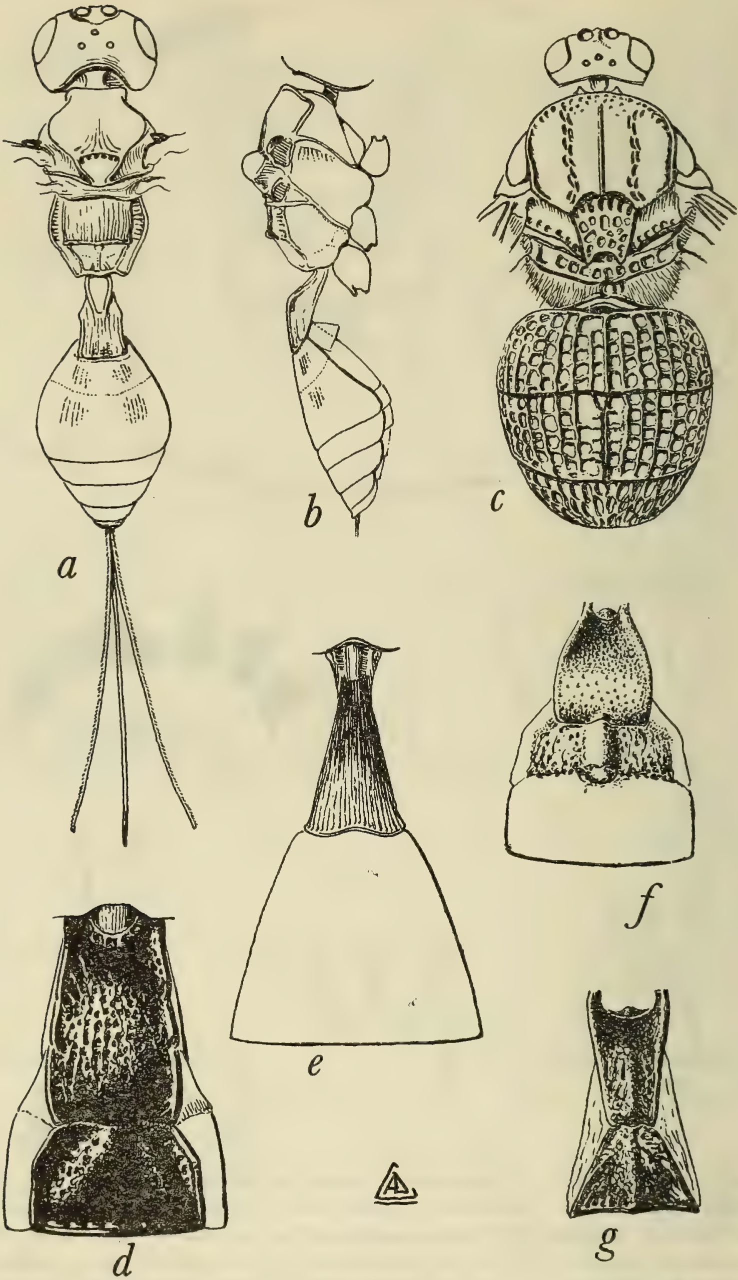

FIGURE 4.—*a*, Dorsal view and, *b*, lateral view of *Percnobracon secundus*, new species; *c*, dorsal view of body of *Fornicia balloui*, new species; *d*, first and second tergites of *Apanteles schini; e*, base of abdomen of *Microctonus audax*, new species; *f*, first, second, and third tergites of *Apanteles alius*, new species; *g*, first and second tergites of *Apanteles malthacae*, new species.

***Promicrogaster miranda*, new species**

FIGURES 1,*p*; 2,*e*

This species is known to me from a single female specimen. It is very similar to the genotype, *P. terebrator* Brues and Richardson, 1913, but may be distinguished by its reddish yellow legs.

FEMALE: Length 6 mm. Head much narrower than thorax; clypeal foveae below level of lower eye margins; malar space more than half as long as width of face; clypeus unusually long, rather flat, broadly emarginate at apex; face and clypeus closely punctate and thickly hairy; vertex and temples finely and closely punctate, the punctures in large part concealed by the dense pilosity; antennae a little shorter than the body.

Thorax very stout; mesoscutum closely punctate and densely pilose; disc of scutellum longer than broad at base, with a few scattered punctures and with a fringe of long hairs along the sides; polished area each side of the disc triangular and occupying nearly all of the lateral face of scutellum; propodeum finely roughened toward base, with coarse rugae apically and with a complete, prominent median longitudinal carina; mesopleuron punctate and hairy anteriorly and below the longitudinal impression, smooth and virtually bare in the impression and above it, posterior groove foveate; metapleuron coarsely punctate and thickly hairy; hind coxa nearly as long as femur, smooth and shining; inner calcarium of hind tibia not quite half as long as metatarsus; stigma very narrow, at least three times as long as its greatest breadth, much shorter than metacarpus; first abscissa of radius about as long as 1st abscissa of cubitus, evenly arched, five times as long as first intercubitus; second cubital cell minute; second intercubitus very weak.

Abdomen large; first tergite parallel-sided, gently and broadly excavated on basal half, emarginate at apex, its lateral margins prominent, its lateral apical angles rounded, its surface smooth and shining; second tergite smooth and shining, at least three times as broad as long down the middle where it is much longer than at the sides; third and following tergites smooth and polished; hypopygium large and plowshare-shaped; ovipositor sheath slender, 4 mm. long.

Head and thorax black; clypeus reddish yellow except at base; labrum and scape testaceous; pedicel and flagellum of antenna dark brown; tegulae and wing bases white; wings whitish hyaline; costa yellowish white; stigma brown, pale at base and apex, most of the veins hyaline; legs, including all coxae, yellowish red; posterior legs a little more reddish than the others and having the apices of tibiae and the tarsi blackish; abdomen reddish yellow with black blotches medially on tergites 4 to 8, those on tergites 5 and 6 the largest.

TYPE: USNM 63051.

TYPE LOCALITY: Barro Colorado Island, Canal Zone.

Described from a single female collected by James Zetek early in 1944.

***Promicrogaster munda*, new species**

In habitus and size this species approaches *P. miranda*, but in the sculptured first tergite, the lack of a median carina on the propodeum, and the relatively short malar space it is more similar to *P. polyporicola*, from which it is easily distinguished, however, by the color characters given in the key.

FEMALE: Length 5 mm. Face and clypeus with shallow, closely placed punctures; malar space longer than clypeus but less than one-third as long as eye or width of face; antennae about as long as body.

Mesoscutum shining but covered with closely placed, shallow punctures and fine hair, the hair longest and most conspicuous in the converging, shallow depressions of posterior half that represent the undeveloped notaulices; propodeum finely rugulose, without a median carina, not or barely longer than scutellum; mesopleuron finely, closely punctate and shining except posteriorly where it is polished and impunctate; metapleuron smooth at base, finely rugulose at apex; hind coxa large, fully twice as long as propodeum, shining, weakly punctate; stigma three times as long as broad; metacarpus much longer than stigma; outer side of first cubital cell strongly arched; nervellus a little curved.

Abdomen compressed, much narrower than thorax; sclerotized plate of first tergite narrowing gradually from base to apex, finely rugulose on apical half; median plate of second tergite smooth and shining, defined laterally by oblique grooves, more than twice as wide on posterior margin as long down the middle, about half as long as third; third and following tergites smooth and polished; ovipositor sheath 1½ times as long as abdomen; ovipositor decurved at apex.

Head and thorax black; scape reddish brown at base in front; lower edge of clypeus and the labrum reddish yellow; palpi and labium a little paler; tegulae transparent yellow; wing bases pale yellow; wings hyaline, stigma dark brown; legs, including all coxae, reddish yellow (hind tarsi missing); abdomen reddish yellow, median plate of first tergite apically, and the fourth and following tergites medially, piceous; ovipositor sheath blackish.

TYPE: USNM 63052.

TYPE LOCALITY. Tegucigalpa, Honduras.

Described from a single female specimen collected July 23, 1917, by F. J. Dyer.

***Promicrogaster polyporicola*, new species**

This new species may be distinguished from *P. terebrator* and *P. miranda* by its smaller size, lack of a median carina on the propodeum, sculptured first tergite and relatively shorter malar space; from *P. munda* it is easily separated by its smaller size and by the color characters given in the key.

Female: Length about 4 mm. Face and clypeus strongly shining, covered with closely placed, very shallow punctures; malar space about as long as clypeus, less than one-third as long as width of face; ocellocular line hardly twice as long as greatest diameter of an ocellus; antennae a little shorter than body.

Mesoscutum shining, closely punctate and covered with short pubescence; disc of scutellum smooth and shining, with only a few scattered punctures, the polished area each side of the disc triangular and occupying nearly all of the lateral face; propodeum finely rugulose, with two rather weak, irregular, posteriorly convergent carinae that meet near the middle; stigma about twice as long as wide; second cubital cell minute, barely noticeable, smaller than in any of the other known species of the genus; nervellus straight; hind coxa about as long as hind femur but not nearly twice as long as propodeum, smooth and polished, with only a few punctures on outer upper edge toward base; inner calcarium of hind tibia not nearly half as long as metatarsus.

First tergite narrowing slightly caudad, its basal width about equal to median length of propodeum, finely rugulose; sclerotized plate of second tergite nearly four times as broad on posterior margin as long down the middle, much shorter laterally than at middle, smooth and polished but sometimes with a row of indefinite punctures just before caudal margin; the following tergites smooth and polished; ovipositor sheath longer than abdomen or hind tarsus; ovipositor strongly decurved at apex.

Black; labrum, mandibles and scapes yellow; clypeus more or less reddish on lower half; wings hyaline; stigma dark brown except for a small yellow spot at extreme base; tegulae testaceous; wing bases pale yellow; legs brownish yellow, hind coxa black above at extreme base, hind femur blackish at extreme apex and hind tibia narrowly yellow at base.

Male: Like the female in essential particulars.

Type: USNM 63053.

Type locality: Barro Colorado Island, Canal Zone.

Described from six females and three males reared by James Zetek October and November 1941 from a lepidopterous larva infesting a polyporaceous fungus of the genus *Fomes*.

Dasylagon,[2] new genus

Dasylagon, new genus, resembles *Promicrogaster* Brues and Richardson in its relatively short tibial spurs, long ovipositor and in not having the clypeus distinctly separated from the face; it resembles *Microgaster* Latreille in general habitus and in having the labium not prominently protruding and not deeply bifurcate. From both genera it differs in its very coarsely areolated propodeum and sinuate nervellus, and in having the head, thorax, and coxae, especially the sides of the thorax, conspicuously hairy.

Head much narrower than thorax, immargined behind; antennae 18-segmented, long and thick; eyes hairy; thorax stout; both head and thorax, and the coxae also, conspicuously hairy; prescutellar furrow coarsely foveate; propodeum areolated, the separating carinae very prominent; prepectus immargined; second cubital cell minute; nervellus sinuate; wings very weakly hairy basally; longer calcarium of middle tibia much shorter than middle metatarsus; that of hind tibia less than half as long as hind metatarsus; abdomen broad basally; first tergite very large; hypopygium large, plowshare-like; ovipositor much longer than abdomen.

Type: *Dasylagon aegeriae*, new species.

Key to the two known species of *Dasylagon*

A prominent median carina from base of propodeum to base of areola; nervulus postfurcal by not more than its length . . . . **aegeriae,** new species

Propodeum with a small median area instead of a median carina basad of areola; nervulus postfurcal by much more than its length . . . . **simulans,** new species

Dasylagon aegeriae, new species

Figures 1,*m*,*n*; 2,*g*

D. aegeriae is distinguished from the only other known species as shown in the preceding key.

Female: Length about 5.5 mm. Head noticeably hairy, about two-thirds as wide as thorax; face at least as wide as eye height, smooth and shining with only extremely shallow punctures; malar space as long as clypeus, weakly punctate; ocellocular line twice as long as diameter of an ocellus; antennae as long as the body, the apical third tapering noticeably.

Thorax and coxae covered with long, conspicuous hair; mesoscutum strongly shining, with small, separated punctures; prescutellar furrow divided into six or seven large foveae; disc of scutellum longer than broad, flat, with some weak punctures laterally; lateral face of scutel-

[2] From the Greek *dasys*, hairy, and *lagon*, side.

lum with a large, triangular, hairless, polished area which is separated from the disc by a coarsely foveate groove; metanotum with a few strong rugae and a sharply defined ovate median area; propodeum with two large basal areas separated by a median longitudinal carina that extends to the areola; areola pentagonal, flanked on each side by a large, coarsely rugose area; spiracular area small but sharply delimited; all carinae of propodeum very prominent; mesopleuron smooth and polished, weakly punctate anteriorly; metapleuron rugose; stigma three times as long as broad; outer side of first cubital cell strongly arched; second cubital cell tiny, the second intercubitus very short and slender; nervulus postfurcal by not more than its length; forewing very sparsely hairy on basal half, the submedian cell almost entirely glabrous; nervellus strongly sinuate; inner calcarium of middle tibia only a little more than half as long as metatarsus, that of hind tibia about one-third as long as hind metatarsus.

Abdomen broad basally, narrowing strongly from second tergite to apex, entirely smooth and polished; first tergite very large, broader than propodeum is long, nearly parallel-sided behind the spiracles, somewhat narrowed in front, usually with five or six weak punctures near lateral margin well before apex, posterior margin strongly sinuate; second tergite strongly transverse, its posterior margin straight; hypopygium prominent, plowshare-shaped; ovipositor sheath slender, about as long as head and thorax combined and with a small hook at apex.

Black, the long and abundant hair of head, thorax, and coxae contrastingly pale; labrum red; palpi and labium yellowish brown; antennae entirely black; wings hyaline, stigma nearly black; legs reddish brown, the coxae and trochanters black and the middle and hind tarsi blackish; ovipositor sheath black.

MALE: Essentially like the female.

TYPE: USNM 63054.

TYPE LOCALITY: Medellin, Colombia.

Described from three females and one male reared by F. Luis Gallego from an unidentified aegeriid larva in March 1954.

Dasylagon simulans, new species

This new species is very similar to *D. aegeriae*, but it may be distinguished without difficulty by use of the characters given in the key. In addition, the face is noticeably smoother and the scutellum more strongly sculptured.

MALE: Length about 6 mm. Head much narrower than thorax, densely hairy; face wider than eye height, smooth and shining, impunctate; malar space about as long as clypeus; ocellocular line less than twice as long as diameter of an ocellus.

Thorax and coxae conspicuously hairy; mesoscutum strongly shining, covered with minute, shallow, separated punctures; prescutellar furrow divided into five or six large pits; disc of scutellum longer than broad, rather strongly, in part confluently, punctate; the large polished area of lateral face of scutellum separated from disc and from mesoscutum by coarsely foveate grooves; propodeum rugose, with a small, nearly square, basal median area followed by a large, more or less obovate areola; on each side of these a large basal lateral area, and a still larger apical lateral area the apical lateral angle of which extends prominently caudad; spiracular area nicely defined and rather large; all carinae of propodeum very prominent; mesopleuron closely, finely punctate except for a narrow polished strip along caudal margin; metapleuron coarsely rugose; stigma three times as long as wide; radius curved outwardly, more than three times as long as first intercubitus and four times as long as second; nervulus postfurcal by considerably more than its length; wings very sparsely hairy basally; nervellus slightly sinuate; hind coxa smooth and shining; inner spur of middle tibia about two-thirds as long as middle metatarsus; inner spur of hind tibia less than half as long as hind metatarsus.

Abdomen much narrower than thorax, entirely smooth and polished; first tergite very large, longer than broad, broader than propodeum is long, narrowed from spiracles to base, parallel-sided behind spiracles, slightly emarginate behind; second tergite much shorter than third, three times as broad as long, its posterior margin nearly straight.

Black, with the abundant pubescence of head and thorax silvery; clypeus, mandibles and palpi reddish yellow; wings clear hyaline, stigma dark brown; legs reddish yellow, with all coxae and trochanters and the hind tarsi black.

FEMALE: Essentially like the male; ovipositor as long as head and thorax combined. The only available female specimen has part of its abdomen destroyed, for which reason the male is selected as holotype.

TYPE: USNM 63055.

TYPE LOCALITY: Tegucigalpa, Honduras.

Described from one male and one female collected June 13, 1918, by F. J. Dyer.

Genus *Microplitis* Foerster

Microplitis minutalis, new species

FIGURE 1,*o*

This is the smallest species of *Microplitis* known to me. It is, further, unusual in having all femora somewhat thickened and in having a narrow, triangular, median plate on the second tergite set off by oblique grooves.

Female: Length about 1.6 mm. Head as broad as thorax; temples convex, about as broad as eyes; face broader than eye height, minutely, closely punctate; clypeus very short, about one-fourth as long as face; malar space about as long as clypeus; antennae as long as head and thorax combined.

Thorax depressed, wider than high; mesoscutum smooth and shining, sparsely and very weakly punctate anteriorly, impunctate posteriorly; prescutellar furrow very fine, with numerous minute foveolae; disc of scutellum flat, smooth and polished; propodeum only slightly declivous, largely smooth and shining, with only a little weak, indefinite sculpture; mesopleuron smooth and shining, its posterior groove coarsely foveate; metapleuron smooth and shining; stigma about as long as metacarpus; radius perpendicular to anterior margin of wing and not longer than first intercubitus; second intercubitus weakly developed; hind coxae a little longer than propodeum, smooth and shining; all femora noticeably thickened; inner spur of hind tibia longer than outer and half as long as metatarsus.

First tergite narrowing from base to apex, less than half as wide at apex as at base, smooth and shining, with only a little, very weak sculpture laterally near apex; second tergite with a narrow, triangular, median plate, which is more than twice as long as wide at base and slightly longer than wide at apex, smooth and polished; ovipositor sheath slightly exserted, slender.

Piceous black; mouthparts piceous; antennae black; tegulae brownish black; wings hyaline, stigma dark brown without a pale spot at base; all coxae, trochanters, and femora black; tibiae and tarsi brown.

Male: Like the female except for the antennae, which are as long as the body.

Type: USNM 63056.

Type locality: Angol, Chile.

Described from 7 females and 5 males reared from a lepidopterous leaf miner March 13, 1941, by Paul A. Berry.

Microplitis sordidus (Ashmead), new combination

Apanteles sordidus Ashmead, Trans. Ent. Soc. London (1900), p. 279, 1900.
Microplitis carinata Ashmead, Idem, p. 293, 1900. New synonymy.

Upon examination of the type of *sordidus* in the British Museum some years ago I found it to belong to the genus *Microplitis* and to be identical with *M. carinatus*, over which it has page priority. Both were described from the island of St. Vincent.

Genus *Fornicia* Brullé

Fornicia Brullé, *In* Lepeletier, Histoire naturelle des insectes. Hyménoptères, vol. 4, p. 511; pl. 44, fig. 3, 1846.
Odontofornica Enderlein, Ent. Mitteil., vol. 1, p. 260, 1912.

In the venation of the forewing, in the hairy eyes, and in the 18-segmented antennae, this genus is like *Apanteles* Foerster, but it differs conspicuously from that genus, as well as from all other known Microgasterinae, in having the basal three tergites fused into a large, convex carapace within which the remaining abdominal segments are retracted. It is further distinguished from all other Microgasterinae except *Dirrhope* Foerster in having the prepectus carinately margined. In some species the scutellum is unidentate at the apex, in others it is bidentate, which is the case for all the known Neotropical species. The nervellus is strongly sinuate in all species I have seen.

Key to the Neotropical species of *Fornicia*

1. Median keel of mesoscutum complete 2
   Median keel of mesoscutum present on posterior half but vanishing anteriorly. 3
2. Mesoscutum finely alutaceous and dull, not punctate or rugulose; pleura not unusually hairy . . . . **balloui**, new species
   Mesoscutum shining, not alutaceous but rather punctate or rugulose, especially before posterior margin; pleura so densely hairy that integument is obscured. **pilosa** Cushman
3. Mesopleuron smooth and shining; mesoscutum smooth, impunctate before posterior margin; notaulices shallow but distinct . . . . . **clathrata** Brullé
   Mesopleuron punctate over most of its surface; mesoscutum strongly, confluently punctate or rugose before posterior margin; notaulices not distinct. **surinamensis**, new species

Fornicia balloui, new species

FIGURES 1,*c*; 4,*c*

This new species is distinguished from the other known Neotropical species of *Fornicia* by its finely alutaceous and mat mesoscutum.

FEMALE. Length about 4 mm. Face much broader than long, smooth and shining, with only very shallow setigerous punctures; clypeus with a conspicuous rounded tubercle medially at base; malar space equal to basal width of mandible; frons polished, impressed; temple gradually receding directly from eye margin; occiput polished, impunctate; antennae at least as long as body.

Thorax very stout, only slightly longer than broad; mesoscutum alutaceous and dull, with a small rugulose area each side anteriorly at origin of notaulices; notaulices shallow but rather broad and longitudinally rugulose, nearly parallel throughout; midway between notaulices a well defined and complete longitudinal carina; prescutellar furrow broad and deep; disc of scutellum coarsely rugose, strongly bidentate at apex; mesopleuron polished except narrowly along anterior margin where it is punctate rugulose; metapleuron rugose; hind coxa

polished; inner calcarium of hind tibia slightly more than half as long as the broadened metatarsus.

Abdomen very stout; the three tergites comprising the carapace rather well defined; first tergite vertical in front, the declivity margined above by a scalloped carina, from which there is a median longitudinal keel that is distinct to apex of first tergite and more poorly defined beyond; surface of all three tergites very coarsely longitudinally rugose reticulate; apex of third tergite very weakly emarginate; hypopygium not surpassing apex of third tergite; ovipositor usually concealed.

Black; labrum and palpi brown; antennae entirely black; wings hyaline, stigma and veins dark brown; anterior and middle legs yellowish brown beyond trochanters, except extreme bases of tibiae which are whitish and the apical segment of each tarsus which is dark brown or black; hind leg entirely black except for a conspicuous white annulus covering basal third of tibia and the white calcaria.

MALE. Like the female in all significant particulars except in the color of the hind legs, the femur being yellowish brown with the apex broadly black, and the tibia tricolored, as usual in males of this genus, with approximately the middle third black, the basal third whitish, and the distal third yellowish brown.

TYPE: USNM 63057.

TYPE LOCALITY: Caracas, Venezuela.

Described from 19 females and 6 males reared from larvae of an unidentified species of the cochlidiid genus *Sibine*, by C. H. Ballou, for whom the species is named. This is the longest series of any species of *Fornicia* I have seen.

Fornicia pilosa Cushman

Fornicia pilosa Cushman, Proc. U. S. Nat. Mus., vol. 79, Art. 14, p. 12, 1931.

This is an unusually hairy species. It is still known only from the holotype female, from Costa Rica.

Fornicia clathrata Brullé

Fornicia clathrata Brullé, *In* Lepeletier, Histoire naturelle des insectes. Hyménoptères, vol. 4, p. 512, pl. 44, fig. 3, 1846.

Although the author expressed uncertainty concerning the sex of the specimen, the description leaves little doubt that the type is a male. The type locality is Bahia, Brazil. I am treating as this species five males taken by E. J. Hambleton on March 27, 1930, at Vicosa, Minas Geraes, Brazil, although they have been identified only by comparison with the original description and that description is not altogether satisfactory.

Fornicia surinamensis, new species

F. surinamensis is distinguished from *F. clathrata* Brullé, as I understand that species, by its closely and strongly punctate mesoscutum and finely punctate mesopleuron.

MALE. Length about 4 mm. Head about half as wide as thorax; face very finely but closely punctate; clypeus smooth and shining; ocellocular line a little longer than diameter of an ocellus; distal third of antenna tapering strongly.

Thorax very short and stout; mesoscutum closely punctate, confluently so anteriorly and also before posterior margin; median keel of mesoscutum weak and incomplete, being distinct only on posterior half; notaulices not distinct; scutellum rising a little caudad, coarsely rugose, strongly bidentate at apex; propodeum with a small, subtriangular, smooth and polished, basal median area; each side of this a transverse, basal lateral area that widens laterally and is defined behind by a sinuate carina; laterad of the basal lateral area a small, sharply defined spiracular area; areola very broad and largely smooth; mesopleuron very finely punctate and subopaque over most of its surface, smooth and polished along caudal margin; metapleuron coarsely rugose except for a small polished space at base; radius longer than intercubitus; stigma and metacarpus subequal; inner side of stigma at least twice as long as outer; nervellus strongly sinuate; hind coxa shining but finely, closely punctate; inner calcarium of hind tibia a little more than half as long as hind metatarsus.

Abdomen extremely convex, very coarsely reticulate rugose, with a median longitudinal keel from basal declivity to end of abdomen, this keel irregular and not well defined on second and third tergites; third tergite shorter than first or second, medially sharply emarginate at apex.

Black; palpi pale except at bases; antennae brownish yellow on basal half, dark brown beyond; tegulae and wing bases black; wings hyaline, stigma dark brown with a small pale spot in the membrane at base; all coxae black; trochanters blackish; all femora red, the posterior pair black at apices; fore and middle tibiae and tarsi yellow; hind tibia white on basal third, black on middle third and red on distal third; hind metatarsus black.

TYPE: USNM 63058.

TYPE LOCALITY: Paramaribo, Surinam.

Described from a single male reared from a cochlidiid larva on coconut Feb. 2, 1954.

Genus *Apanteles* Foerster

Apanteles aciculatus (Ashmead)

Urogaster aciculatus Ashmead, Trans. Ent. Soc. London (1900), p. 289, 1900.
Pseudapanteles sancti-vincenti Ashmead, Idem, p. 291, 1900. (*Not Apanteles sancti-vincenti* Ashmead, idem, p. 279.) New synonymy.
Apanteles thoracicus Muesebeck, Proc. U. S. Nat. Mus., vol. 58, p. 534, 1921. New synonymy. This name was proposed to replace the preoccupied *sancti-vincenti*.

Study of the types of *Urogaster aciculatus* and *Pseudapanteles sancti-vincenti* in the British Museum showed them to be the same species. The replacement name, *A. thoracicus*, was proposed before there had been an opportunity for examination of the types. *A. aciculatus* was described from Grenada and *A. sancti-vincenti* from St. Vincent, both in the British West Indies.

Apanteles carpatus (Say)

Microgaster carpatus Say, Boston Journ. Nat. Hist., vol. 1, p. 263, 1836.
Urogaster solitarius Ashmead, Trans. Ent. Soc. London (1900), p. 287, 1900. Preoccupied by *Microgaster solitarius* Ratzeburg, 1844, which has been transferred to *Apanteles*. New synonymy.
Protapanteles hawaiiensis Ashmead, Fauna Hawaiiensis, vol. 1, p. 362, 1901.
Apanteles piceoventris Muesebeck, Proc. U. S. Nat. Mus., vol. 58, p. 515, 1921. Replacement name for the preoccupied *Urogaster solitarius* (Ashmead). New synonymy.
Apanteles igae Watanabe, Ins. Mats., vol. 7, p. 97, 1932.

This species, which is a parasite of the clothes moths and certain other related Tineidae, is virtually world-wide in distribution. I saw the type of *Urogaster solitarius* (Ashmead) in the British Museum and found it to be *Microgaster carpatus* (Say). It was described from the island of Grenada, British West Indies.

Apanteles balthazari (Ashmead)

Urogaster balthazari Ashmead, Trans. Ent. Soc. London, 1900, p. 284, 1900.
Urogaster meridionalis Ashmead, Idem, p, 285, 1900. New synonymy.

Examination of the types in the British Museum showed that these names apply to the same species. Accordingly, *Urogaster meridionalis* is suppressed as a synonym of *Apanteles balthazari*, which has page priority. The former was described from St. Vincent and Grenada, the latter from Grenada.

Apanteles coffeellae, new species

FIGURES 1,*j*; 2,*f*

This species runs to *Apanteles laevicoxis* Muesebeck in my key to the Nearactic and West Indian species,[3] but it differs from that form

[3] Proc. U. S. Nat. Mus., vol. 58, p. 488, 1921.

most conspicuously in its smoother mesoscutum, in having well-developed costulae on the propodeum, and in having the plate of the first tergite strongly narrowed apically and the second and third tergites confluent, in its dark tegulae, and in its much smaller size. *A. leucochiloneae* Cameron, which is closely related, is at once separated by its whitish tegulae and hyaline stigma and by lacking costulae on the propodeum.

Female: Length barely 2 mm. Face shining, faintly punctate; frons polished; vertex and temples weakly punctate; temples rounded, not receding from eye margins; antennae about as long as the body.

Thorax stout; mesoscutum with sharp, though shallow, closely placed punctures over most of its surface, becoming progressively smoother caudad, impunctate and polished before posterior margin; prescutellar furrow a fine punctate line; disc of scutellum nearly flat, impunctate, polished; polished area on lateral face of scutellum triangular, large, extending nearly to base of disc; propodeum largely smooth and shining with distinct costulae and a weakly defined, broad, pentagonal areola; mesopleuron and metapleuron impunctate, polished, the fine impressed line between them not punctate or foveolate; hind coxa impunctate, polished and with an elongate flattened area outwardly above at base; inner calcarium of hind tibia hardly half as long as basitarsus; stigma unusually short, only two-thirds as long as metacarpus; first abscissa of radius about as long as intercubitus, not angled with the latter but joining it in an even curve; petiole of first discoidal cell about as long as recurrent vein; nervellus straight, perpendicular to mediella, not curving behind toward base of wing.

Abdomen short, entirely smooth and polished; plate of first tergite narrowing strongly to apex where it is only one-third as broad as at base; second tergite confluent with third and with a short, oblique groove on each side at base; hypopygium large, prominent; ovipositor sheath very slender, as long as hind femur.

Black; labrum pale yellow; palpi white; antenna dark brown above, yellowish brown beneath, pedicel usually darker than scape and first flagellar segment; legs yellow with base of middle coxa and the hind coxa black, and posterior tibia apically and posterior tarsus more or less dusky, posterior femur immaculate; tegulae and wing bases brownish black, wings hyaline, stigma brown, costa pale yellow, veins hyaline except outer side of first cubital cell; membranous margins of first tergite and venter of abdomen toward base dark brown or piceous.

Male: Differs from female only in the darker legs, the middle femur being slightly dusky, and the posterior femur, together with the posterior tibia except at base, piceous.

Type: USNM 63059.

Type locality: Guadeloupe, French West Indies.

Described from 7 females and 8 males reared from *Leucoptera coffeella* (Guérin-Méneville), Sept. 29, 1937, by F. Sein, Jr.; and 1 female and 7 males reared by Mr. Sein in Puerto Rico from *Acrocercops dives* (Walsingham).

Apanteles lipomeringis, new species

This species is distinguished from all known related species by being entirely yellow except for the antennal flagellum and by having the first tergite deeply longitudinally channeled and the propodeum provided with an unusually prominent median longitudinal carina.

Female: Length about 2.6 mm. Head noticeably hollowed out behind; temples receding; face and clypeus minutely punctate and shining; malar space not quite as long as clypeus; frons and temples smooth and shining; antennae not tapering to apices, about as long as the body.

Mesoscutum weakly, minutely punctate and shining, like face; prescutellar furrow finely foveolate; disc of scutellum flat, slightly broader at base than long, smooth and shining; propodeum smooth, with a very prominent, complete, median longitudinal carina; mesopluron and metapleuron impunctate, polished; hind coxa smooth and polished; inner calcarium of hind tibia longer than outer but hardly half as long as metatarsus; metacarpus longer than stigma; first abscissa of radius about as long as intercubitus and strongly angled with it; nervellus oblique but not curved toward base of wing.

Abdomen much narrower than thorax; first tergite narrowing from base to apex, at widest point about half as wide as propodeum, deeply, longitudinally channeled along middle line from base almost to apex, mostly smooth with only a few weak punctures on apical third; median plate of second tergite defined laterally by strongly oblique grooves, broader at base than long, about twice as wide at apex as at base, impunctate, polished; remainder of abdomen polished; ovipositor sheath slender, about as long as hind tarsus.

Entirely yellow, with only flagellum and a blotch on front of scape brown; wings subhyaline; stigma, costal margin, and veins brown.

Male: Like the female except for the longer, somewhat tapering antennae and the relatively slightly longer second tergite.

Type: USNM 63060.

Type locality: Summit, Canal Zone.

Described from 1 female (type) and 6 males reared from the larva of *Lipomerinx prismatica* Walsingham, Apr. 14, 1927, by James Zetek, under his No. 2793.

Apanteles alius, new species

Figure 4,*f*

This species is very similar to *Apanteles glomeratus* (Linnaeus), and is easily confused with that species. It may be distinguished, however, by the paler coxae, the darker costa, the less shining and more evenly sculptured mesoscutum, the absence of a median longitudinal impression at the base of the propodeum, and the relatively broader second tergite, the sculptured part of which is not defined laterally by oblique grooves as in *A. glomeratus*. From *A. opsiphanis* Schrottky, which is known to me only from the original description, it differs in the much paler legs and the smoother second tergite. In both *A. glomeratus* and *A. opsiphanis* all coxae are black or blackish.

Female: Length about 2.5 mm. Face smooth and shining, faintly punctate each side of middle; antennae slender, at least as long as the body. Mesoscutum closely, evenly punctate and subopaque; prescutellar furrow sharp, foveate; disc of scutellum smooth and polished, with only a few scattered, shallow punctures; propodeum strongly rugulose, the median longitudinal carina incomplete or wanting, the spiracles prominent; mesopleuron largely smooth and polished, posterior groove finely foveolate; metapleuron impunctate and polished on basal half, rugose and dull on apical half; hind coxa smooth and shining but with a small, flattened, punctate area on upper edge at base; inner calcarium of posterior tibia not, or barely, longer than outer and not distinctly half as long as metatarsus; metacarpus slightly longer than stigma; first abscissa of radius perpendicular to anterior margin of wing, longer than intercubitus and joining it in a weak angle; nervellus strongly oblique but straight.

Abdomen rather stout, almost as broad as thorax; sclerotized plate of first tergite broadening gradually from base to apex, a little longer than broad at apex, smooth on basal half, punctate apically; second tergite rectangular, more than twice as broad as long, much shorter than third, smooth and polished medially, usually finally rugulose toward sides; second suture very fine; third and following tergites impunctate, polished; ovipositor sheath subexserted.

Black; labrum and mandibles brown; palpi pale yellow; antennae wholly brownish black; wings hyaline; stigma and veins brown; anterior and middle legs, including coxae, yellow, immaculate; hind leg yellow with basal half of coxa, apex of femur, apex of tibia and the tarsus, black; abdomen bright yellow on sides and beneath on basal half.

Male: Differs from the female only in its considerably longer and more slender antennae.

Type: USNM 63061.

Type locality: El Valle, Venezuela.

Described from 14 females and 1 male reared from *Opsiphanes c. cassiae* (Linnaeus) on *Musa sapientum* at the type locality, Mar. 16, 1939, by C. H. Ballou; and 4 females and 1 male reared from *Opsiphanes* sp. at Campinas, São Paulo, Brazil, July 27, 1937, by H. F. G. Sauer.

Apanteles ornatricis, new species

This species is very similar to *Apanteles orobenae* Forbes and *A. glomeratus* (Linnaeus), but differs from the former in not having the mesoscutum confluently punctate, in the paler coxae, in the narrower first tergite and in the straight nervellus, and differs from the latter in the more completely sculptured first tergite and the shorter radius.

Female: Length about 2.3 mm. Head about as wide as thorax; face closely, shallowly punctate, about as wide as eye height; malar space as long as clypeus; antennae as long as body.

Mesoscutum rather uniformly punctate, the punctures contiguous but not confluent; prescutellar furrow with around eight foveae; scutellum large, smooth and shining; propodeum rugose, usually with a more or less distinct median longitudinal carina; mesopleuron smooth and polished except for a small area below tegula which is confluently punctate; metapleuron rugose except for a small polished space at base; radius issuing from slightly beyond middle of stigma and not longer than intercubitus, with which it is sharply angled; nervellus strongly oblique but perfectly straight; hind coxae smooth and polished, impunctate; inner calcarium of hind tibia barely longer than outer and less than half as long as hind metatarsus.

Abdomen much narrower than thorax; first tergite distinctly longer than broad, broadening only very slightly from base to apex, closely rugulose, the apical angles somewhat rounded off, membranous margins broad apically; second tergite much shorter than third, with a central rugulose area that is twice as wide on posterior margin as long; laterally second tergite smooth and shining, without sutures delimiting the sculptured part; third and following tergites smooth and polished; ovipositor sheath subexserted.

Black; labrum reddish yellow; antennae brownish black with scape sometimes pale beneath; tegulae and wing bases dark brown; wings hyaline, stigma brown; anterior coxae piceous; middle coxae yellow, piceous at bases above; hind coxae black, yellowish apically below; remainder of legs honey yellow, except extreme apices of hind femora above, hind tibiae apically and hind tarsi, which are weakly infuscated; abdomen black, yellow beneath on basal half, also lateral unsculptured margins of first and second tergites yellowish and sometimes the third tergite more or less reddish yellow apically.

Male: Like the female but with the middle and hind coxae more completely piceous or black.

TYPE: USNM 63062.

TYPE LOCALITY: Chincina, Colombia; altitude 1380 meters.

Described from 6 females (including holotype) and 6 males reared from *Utetheisa ornatrix* (Linnaeus) at the type locality by A. Cabal-O. May 14, 1942; 9 females and 2 males reared from the same host at La Esperanza, Colombia, by R. Paul Roba, Jan. 26, 1938; 16 females reared from *U. ornatrix*, "Valle de Medellin y Atlantico," Colombia, and 9 females and 12 males, also from that host, reared by R. de Tella at Campinas, Brazil, in 1952.

Apanteles politiventris, new species

This new species may be readily recognized by the combination of a large, apically squarely truncate, and completely polished central plate of the first tergite and an ovipositor sheath that is nearly 1½ times as long as posterior tarsus.

FEMALE: Length about 2 mm. Head thin; malar space a little longer than clypeus; clypeal foveae represented by two sharp punctures which are on or below lower level of eyes; face, clypeus, frons, and vertex smooth and shining; temples faintly punctate posteriorly; antennae about as long as the body.

Thorax stout, a little broader than high; mesoscutum largely very finely, contiguously or confluently punctate and opaque, but smooth and shining at posterior margin, thickly covered with short pile; disc of scutellum flat, impunctate and polished; polished area on lateral face of scutellum semicircular, rather small; propodeum punctate and shining on dorsal face, but with some rugae on posterior face, and with a large, roughly circular areola which is smooth and shining and sharply margined; costulae not distinct; mesopleuron smooth and polished, the posterior furrow minutely foveolate; metapleuron smooth and polished except narrowly at apex; hind coxae smooth and polished; inner calcarium of hind tibia barely longer than outer and not half as long as metatarsus; metacarpus a little longer than stigma; first abscissa of radius slightly curved, much longer than intercubitus which it joins in a very weak angle; nervellus slightly curved.

Abdomen smooth and polished with no trace of sculpture; median plate of first tergite large, parallel-sided, only slightly longer than broad, squarely truncate at apex, with no indication of a median fovea but slightly impressed in the apical lateral angles; plate of second tergite more than four times as broad as long, much shorter laterally than at middle, its posterior margin very faint; ovipositor sheath very slender, distinctly longer than the abdomen.

Black; scape black; flagellum dark brown; palpi somewhat infuscated; legs black or blackish; trochanters, apical half of fore femur, fore tibia and tarsus, bases of middle and hind tibiae, and middle

tarsus except last segment brownish yellow; tegulae and wing bases whitish; wings whitish hyaline; costa yellowish white; stigma hyaline margined with brown; metacarpus brown; other veins hyaline.

TYPE: USNM 63063.

TYPE LOCALITY: Santurce, Puerto Rico.

Described from 13 females reared by A. S. Mills on May 19, 1934, from lepidopterous larvae on *Pluchea purpurascens*.

***Apanteles impiger*, new species**

Most similar to *Apanteles pseudoglossae* Muesebeck but without distinct costulae on the propodeum, with ovipositor sheath relatively much longer and with the male legs and tegulae darker.

FEMALE: Length 2.3 mm. Face closely shallowly punctate; clypeus punctate; malar space as long as clypeus; temple rounded; vertex and temples closely punctate; antenna about as long as body and covered with conspicuous, short, white pubescence.

Thorax stout; mesoscutum closely, in part confluently, punctate, more or less rugulose posteriorly, mat; scutellar furrow deep and broad, strongly foveolate; disc of scutellum flat, shining, smooth although sometimes with a few very weak punctures; polished area on lateral face of scutellum semicircular, remainder of lateral face traversed by numerous carinae radiating from polished area; propodeum rugulose and dull except in the areola which is large, more or less pentagonal, and open at base, costulae incomplete or wanting, posterior lateral angles not prominent; mesopleuron smooth and shining except anteriorly and below where it is closely punctate and dull, impressed line along posterior margin very fine and faintly foveolate; metapleuron smooth except at extreme apex; hind coxa smooth, shining; inner calcarium of hind tibia slightly more than half as long as basitarsus; first abscissa of radius slightly curved, very slender, longer than intercubitus which it joins in an even curve; metacarpus longer than stigma; nervellus curved below toward base of wing.

Abdomen rather narrow, shorter than thorax; plate of first tergite large, parallel-sided to apical fourth and then narrowing a little to apex, closely rugulose and dull except for a narrow, shallow, and sometimes poorly defined, median longitudinal impression on apical half which is shining; plate of second tergite about twice as wide at base and nearly four times as wide at apex as long down the middle, mostly smooth and polished, but sometimes a little rugulose along apical margin; hypopygium acute at apex, extending slightly beyond apex of last dorsal segment; ovipositor sheath about as long as hind tibia.

Black; palpi yellow; antenna entirely black, including scape; tegulae and wing bases yellow; wings hyaline, costa yellow, stigma

and outer side of first cubital cell pale brown, other veins hyaline; legs entirely bright yellow except anterior coxae piceous, middle and hind coxae black and apices of posterior tibiae and the posterior tarsi infuscated; hind femora with no suggestion of infuscation at apices; abdomen entirely black above and below.

Male: Essentially like the female, but tegulae and wing bases brownish, trochantines of all legs, middle and hind femora, and apical half of posterior tibia piceous.

Cocoons: Solitary, pure white.

Type: USNM 63064.

Type locality: Mayaguez, Puerto Rico.

Described from 8 females and 7 males reared from the melonworm, *Diaphania hyalinata* (Linnaeus), Nov. 10, 1943, by H. K. Plank. I have also seen 3 specimens reared from the same host at Santiago de las Vegas, Cuba, by A. Otero, Sept. 28, 1931.

Apanteles croceicornis, new species

This new species is recognizable by the unusual color combination of the antenna, the scape being black and the flagellum orange yellow, and by the strongly tuberculate lateral angles of the propodeum.

Female: Length about 2.6 mm. Face and clypeus minutely punctate and shining; temples strongly convex; malar space as long as clypeus; antennae slightly shorter than body.

Mesoscutum evenly and contiguously punctate and rather dull, the punctures minute and very shallow; disc of scutellum smooth and shining; polished area on lateral face of scutellum large, semicircular, the area anterior to it crossed by numerous strong rugae; propodeum entirely rugose, with a distinct areola that is margined by strong carinae on posterior half, costulae incomplete, posterior lateral angles very prominent, tuberculate; mesopleuron polished above and posteriorly, closely strongly punctate and dull below and anteriorly; metapleuron mostly smooth but rather dull; hind coxa smooth and shining; inner calcarium of hind tibia not distinctly half as long as metatarsus; first abscissa of radius and intercubitus subequal, meeting in a strong angle.

Abdomen narrower than thorax; plate of first tergite nearly parallel-sided on basal half, narrowing strongly from middle to apex, about as wide at apex as second tergite is long, closely rugulose except at base and with a poorly defined, elongate, impressed area in middle of posterior half, extreme apex smooth and polished; lateral membranous margins of first and second tergites very broad; plate of second tergite strongly transverse, nearly three times as broad at apex as it is long or broad at base, defined laterally by sharp, oblique grooves, faintly alutaceous and opaque; remainder of abdomen smooth and shining; ovipositor sheath nearly as long as hind femur.

Black; scape black, pedicel and basal two-thirds of flagellum orange yellow, apical fourth of flagellum brownish; tegulae and wing bases entirely yellow; wings hyaline, stigma and veins light brown; legs including all coxae and tarsi golden yellow; plates of first and second tergites black, the membranous margins yellow; third tergite mostly yellowish, usually blackish at base and sometimes at apex; venter of basal three abdominal segments bright yellow; abdomen beyond third segment entirely black.

MALE: Like the female except in having the antennae yellow almost to the apices, in the relatively narrower plate of second tergite and in the largely piceous third tergite.

COCOON: Pure white, solitary.

TYPE: USNM 63065.

TYPE LOCALITY: Cañete, Peru.

Described from two females and two males reared by E. J. Hambleton from *Asciodes anormalis* (Guenée) on sweet potato.

Apanteles malthacae, new species

FIGURE 4,*g*

Exceedingly like *Apanteles sarrothripae* Weed and rather difficult to distinguish from that species; however, the central plates of the first and second tergites are narrower, and, unlike that of *A. sarrothripae*, the hind coxa has the outer upper edge more or less flattened toward base and confluently punctate; furthermore, the hind femur is blackish at apex whereas that of *A. sarrothripae* is wholly yellow.

FEMALE: Length about 2.5 mm. Face smooth and shining; antenna about as long as body; vertex and temples polished; ocellocular line at least twice as long as diameter of an ocellus.

Mesoscutum strongly shining and nearly smooth, with only very minute, extremely shallow, separated punctures; scutellum smooth and shining; propodeum smooth and shining across base, its posterior declivity gradual and weakly roughened; mesopleuron smooth and polished but with some shallow separated punctures below anteriorly; hind coxa with a confluently punctate, more or less flattened area on outer upper edge toward base; inner spur of hind tibia very slightly longer than outer and not, or barely, half as long as metatarsus; radius longer than intercubitus and strongly angled with it.

Abdomen compressed, less than half as wide as thorax; first tergite narrowing gradually caudad, three times as long as broad at apex, finely rugulose on apical half; sclerotized plate of second tergite triangular, nearly twice as long and more than twice as wide on posterior margin, as broad at base, finely rugulose; third and following tergites polished; ovipositor sheath extending slightly beyond apex of abdomen.

Black; antennae blackish, scape brownish yellow beneath; stigma dark brown; tegulae and wing bases yellow; anterior and middlelegs entirely yellow, including coxae; hind legs yellow, with coxae, apices of femora and of tibiae, and more or less of the tarsi black or blackish.

TYPE: USNM 63066.

TYPE LOCALITY: Río Blanco, Vera Cruz, Mexico.

Described from 17 females and 31 males reared by Owen J. Smith in 1951 from the larvae of *Malthaca* sp. on wild grape.

Apanteles concinnus, new species

FIGURE 2,*a,i*

This new species somewhat resembles *Apanteles muesebecki* Blanchard but it is easily distinguished by the exceptionally long and narrow sclerotized plate of the second tergite, the presence of some sculpture on the plates of both the first and second tergites, and the darkened base of the hind tibia. Reared specimens are easily identified by the very unusual cocoons (fig. 2,*i*).

FEMALE: Length about 2.5 mm. Face flat, shining, almost impunctate, and with a low median keel above; temple narrow but not sharply receding; malar space at least as long as clypeus; antennae slender, longer than body.

Mesoscutum shining, with numerous, but not contiguous, minute, and very shallow setigerous punctures; scutellum convex, impunctate, polished; propodeum shining, smooth basally, a little roughened behind middle; mesopleuron and metapleuron and hind coxa polished, impunctate; inner calcarium of hind tibia half as long as metatarsus; first abscissa of radius arising from middle of stigma, as long as, or a little longer than, intercubitus.

Abdomen hardly half as wide as thorax; plate of first tergite narrowing from base to apex where it is less than half as wide as second tergite is long, weakly roughened on apical third, smooth at extreme apex; plate of second tergite narrowly triangular, its basal width equal to apical width of first tergite, its apical width about equal to its length, its sides defined by straight, sharply impressed lines that diverge caudad, its surface mostly smooth and polished but with a little very weak sculpture toward lateral apical angles; third and following tergites smooth and shining; ovipositor sheath not surpassing last tergite.

Black; antennae entirely black; palpi pale yellow; tegulae yellow; wing bases brownish; wings hyaline, stigma and veins brown; legs testaceous, hind coxae piceous, extreme apex of hind femur, base and apex of hind tibia and the hind tarsus infuscated; basal half of abdomen yellow on sides and venter.

MALE: Like the female in essential details.

Cocoon: White, solitary. Of remarkable form, being 6-sided, with two large concave lobes representing extensions of the cocoon wall at the posterior end, and with the rim of the anterior end ornamented with six slightly flaring elongate lobes, each one nearly as long as anterior width of cocoon.

Type: USNM 63067.

Type locality: Campinas, São Paulo, Brazil.

Described from three females and two males reared by H. F. G. Sauer in July and October 1937; and three females and one male reared in July 1937 by L. Mendes. Both series are from the type locality and from larvae of an unknown species of Lepidoptera.

Apanteles stenomae, new species

This new species immediately suggests *Apanteles concordalis* Cameron, which it closely resembles in sculpture and color as well as in general structure. However, it is smaller; it lacks distinct costulae on the propodeum (which are well developed, in *A. concordalis*), and it has a more slender abdomen, with the first tergite about twice as long as broad at apex.

Female: Length about 2.5 mm. Face as wide as eye height, closely and more or less confluently punctate, and subopaque; vertex and frons finely rugulose and largely dull; antennae a little shorter than body.

Mesoscutum strongly, closely, and in part confluently punctate and dull; disc of scutellum flat, faintly shagreened, and with scattered, very shallow punctures; polished area each side of disc rather large but not nearly extending to base of lateral face, the broad depression in front of it largely smooth and shining (in *A. concordalis* it is crossed by a number of strong, longitudinal rugae); propodeum rugose, with a well defined areola which narrows caudad and is open at base; costulae wanting; spiracular area defined by an irregular carina; apical lateral angles of propodeum acute, projecting caudad; mesopleuron mat, confluently punctate anteriorly, but the punctures becoming progressively weaker and more widely separated on a shagreened surface posteriorly; metapleuron polished at base, dull, and sculptured apically; radius nearly perpendicular to anterior margin of wing, somewhat longer than intercubitus and weakly angled with it; nervellus strongly curved behind toward base of wing; hind coxa impunctate but weakly shagreened and mat on outer side; inner spur of middle tibia very nearly as long as middle metatarsus; that of hind tibia much longer than outer and about half as long as hind metatarsus.

Abdomen much narrower than thorax; first tergite nearly parallel-sided, about twice as long as wide at apex, finely longitudinally rugulose, and with a low median tubercle just before middle, behind

which there is a poorly defined median longitudinal impressed area; median plate of second tergite 2½ times as broad on posterior margin as long medially, defined laterally by fine, sharply impressed, posteriorly divergent grooves, the surface of the plate virtually smooth, with only a faint suggestion of sculpture; third and following tergites smooth and polished; ovipositor sheath at least as long as hind tarsus.

Black; antennae, including scape, blackish; maxillary palpi pale except basally; tegulae pale yellow; wing bases piceous; wings hyaline, stigma and veins hyaline; legs black, the anterior femora pale distally, the anterior and middle tibiae and tarsi brownish yellow, and the hind tibia yellowish brown on basal half.

Male: Like the female but a little smaller and with the antennae a little longer than the body.

Type: USNM 63068.

Type locality: El Valle, Venezuela.

Described from 14 females and 5 males reared by C. H. Ballou from larvae of a species of *Stenoma*, Sept. 30, 1941.

Apanteles dentatus, new species

Characterized especially by very prominent posterior lateral angles of the propodeum, sharply margined propodeal areas, a punctate scutellum, a median fovea on the first tergite, a straight posterior margin of the second tergite, and an unusually long ovipositor.

Female: Length about 3.2 mm. Face closely punctate, subopaque, with an indication of a median keel; upper part of frons, vertex, and temples strongly punctate, in part confluently so; antennae about as long as body.

Mesoscutum closely, strongly punctate, the sculpture becoming more or less longitudinally rugulose posteriorly as a result of confluence of punctures and extending to extreme posterior margin; prescutellar furrow deep and broad, foveolate; disc of scutellum with scattered but sharp and distinct punctures, shining; polished area on lateral face of scutellum subtriangular, extending at least halfway toward base of scutellum; propodeum rugose and dull; areola large, obovate, narrowed posteriorly, weakly closed anteriorly; costulae present; apical lateral areas rugose; apical lateral angles acute and strongly produced caudad; mesopleuron coarsely, confluently punctate and opaque on anterior half, mostly smooth and shining behind, the impression with fine, concentric striulae; metapleuron with a small anterior section impunctate and polished, the larger posterior portion coarsely rugulose; posterior coxa largely smooth and subopaque, with a flattened punctate area on outer upper edge at base; inner calcarium of hind tibia about half as long as metatarsus; metacarpus conspicuously longer than stigma; first abscissa of radius much longer

than width of stigma or than intercubitus; nervellus strongly curved toward base of wing.

Abdomen about as long as thorax; plate of first tergite broadening imperceptibly caudad, at least 1½ times as long as broad at apex, apical half rugulose and with a large median longitudinal fovea; plate of second tergite mostly smooth and shining but with a few weak punctures along the practically straight posterior margin, the plate four times as broad as long and half as long as third tergite; third and following tergites smooth and shining; ovipostor sheath uniformly slender, considerably longer than hind tarsus.

Black; labrum brownish; palpi pale; scape pale brown at base; tegulae and wing bases yellow; costa yellow toward base, darkening toward stigma; wings clear hyaline; stigma dark brown; all coxae entirely black, anterior and middle legs entirely testaceous beyond coxae; posterior trochanter and femur deep testaceous, the latter blackish at apex; posterior tibia yellowish white on basal fourth, testaceous beyond except for a broad blackish apical band; metatarsus pale yellow at base, remainder of tarsus blackish.

Cocoon: Solitary; pure white; not cylindrical, but with four or five rather flat surfaces, the posterior end extended nipple-like.

Type: USNM 63069.

Type locality: Campinas, São Paulo, Brazil.

Described from 6 female specimens, all from the type locality, the type and 1 paratype reared from *Platynota rostrana* (Wlkr.) by H. F. G. Sauer on Aug. 8, 1937, 2 paratypes reared from an unknown lepidopterous larva by E. J. Hambleton in April 1936, 1 paratype from *Paraptila* sp., reared by Mr. Hambleton on Jan. 5, 1937, and 1 paratype from a lepidopterous larva on citrus reared by Mr. Hambleton on Mar. 6, 1939.

Apanteles hedyleptae, new species

Very similar to *Apanteles parallelis* (Ashmead), which is known only from the unique type from St. Vincent in the British Museum, but distinguished from that species by its sculptured first tergite, yellow tegulae, and darker hind femora.

Female: Length about 2.8 mm. Head smooth and shining; face with some very weak and minute punctures; malar space not quite as long as clypeus; face narrowing slightly below, at narrowest point not quite as broad as eye height; antennae almost as long as body; temples convex, not strongly receding.

Mesoscutum shining, with extremely shallow, separated punctures; disc of scutellum flat, smooth and shining, polished area on lateral face of scutellum semicircular, not large; propodeum convex, smooth and shining, with only scattered punctures on dorsal surface and a

little rugosity in apical lateral angles; mesopleuron entirely smooth and polished; radius arising from beyond middle of stigma, not longer than intercubitus; nervellus very oblique but straight; hind coxa very large, smooth and shining, and with a conspicuous, flattened, weakly punctate area on outer upper edge basally; inner calcarium of hind tibia slightly longer than outer but much less than half as long as hind metatarsus.

Abdomen much narrower than thorax; first tergite parallel-sided, smooth and polished on basal half, very finely roughened and subopaque apically, with a very shallow, poorly defined, median longitudinal impressed area on caudal half immediately in front of which is a low polished tubercle; plate of second tergite very transverse, four times as wide as long, defined laterally by fine oblique grooves, its posterior margin a little curved, so that plate is longer medially than laterally, its surface largely smooth but sometimes with delicate longitudinal roughening; remaining tergites smooth and polished; ovipositor sheath at least as long as hind tibia.

Black; palpi pale; antennae entirely black; tegulae and wing bases yellow; wings hyaline, stigma dark brown; legs brownish yellow, with all coxae black, and hind femora on upper and lower edges, hind tibiae apically, and hind tarsi more or less infuscated.

Male: Unknown.

Type: USNM 63070.

Type locality: Barceloneta, Puerto Rico.

Described from 17 females reared from *Hedylepta indicata* Lederer in beans and 5 females reared from *Maruca testulalis* Geyer, also in beans. All the specimens are from the type locality and were reared in February 1950 by H. K. Plank.

Apanteles conformis, new species

This new species is exceedingly like *Apanteles talidicida* Wilkinson, which was reared from the hesperiid *Talides sergestus* Cramer in British Guiana, but it may be distinguished from that species by its blackish tegulae, nonangulate nervellus, and more extensively blackish hind femora of the female. From *A. disputabilis* (Ashmead), which was described from the island of St. Vincent and which it also closely resembles, it differs most conspicuously in its dark tegulae and stigma and in having the nervellus strongly curved behind, toward base of wing. In all three species the malar space is rather long and is covered with a pale yellow blotch.

Female: Length about 3.7 mm. Head smooth and shining, not distinctly punctate, covered with fine and rather dense pubescence; malar space longer than clypeus and about one-third as long as width of face; antennae as long as body.

Mesoscutum shining, very finely punctate, the punctures separated and posteriorly becoming sparse and very weak; prescutellar furrow with eight or ten foveae; disc of scutellum a little longer than broad, smooth and polished, impunctate; polished area each side of disc fairly large and subtriangular but not extending nearly to base of lateral face; propodeum rugose, completely areolated, the separating carina very prominent, the areola very large, broadly oval, closed at base by the caudal margin of the small basal median area; mesopleuron smooth and shining, weakly punctate anteriorly, and with a long hair arising from each puncture; metapleuron coarsely rugose except for a small polished space at base; radius directed outward, considerably longer than intercubitus which it joins in a sharp angle; hind coxae smooth and polished; inner calcarium of hind tibia much longer than outer and half as long as metatarsus

First tergite nearly parallel-sided, smooth basally, finely rugulose on posterior half where there is a median longitudinal, slightly impressed area that is sharply margined anteriorly but indefinitely delimited behind; second tergite more than half as long as third, three times as broad as long, its posterior margin straight; second and following tergites polished; ovipositor sheath rather slender, slightly longer than hind metatarsus.

Black; malar space covered by a large, pale yellow spot; labrum and palpi light brown; antennae entirely black; tegulae black, wing bases brown; wings hyaline basally, a little clouded apically; costa, stigma, and veins dark brown; all coxae black and the trochanters largely so; hind femur blackish on apical half; hind tibia at extreme apex and hind tarsus, except metatarsus basally, piceous to black.

Male: The single available male has the hind femora black only at the apices; otherwise it is similar to the females.

Type: USNM 63071.

Type locality: El Valle, Venezuela.

Described from 17 females and 1 male reared Mar. 8, 1939, by V. Obregon from an unknown hesperiid larva on *Canna indica*.

Apanteles megastidis, new species

Very similar to *Apanteles thurberiae* Muesebeck but distinguished by its reddish yellow hind femora and its strongly developed propodeal costulae.

Female: Length about 4 mm. Head uniformly closely and finely punctate and more or less mat; temples receding; clypeus punctate like face; malar space longer than clypeus; antennae a little shorter than body.

Mesoscutum closely, in part confluently, punctate and dull; prescutellar furrow very fine, comprised of about ten small foveae; disc of

scutellum longer than broad, flat, smooth, and polished; a large, triangular, polished area each side of disc covering nearly all of lateral face of scutellum; propodeum finely rugose dorsally, with a large, ovate areola that is open at base, and with strong costulae that set off large, shining, lateral apical areas which are traversed by a few strong, irregular rugae; mesopleuron shining, closely punctate anteriorly, the punctation becoming more sparse behind and vanishing before posterior margin; no longitudinal impression below on mesopleuron; metapleuron posteriorly confluently punctate and dull; radius much longer than intercubitus, the latter only weakly oblique; nervellus very slightly curved; hind coxa smooth and polished outwardly, closely punctate above toward base; inner calcarium of hind tibia much longer than outer and very nearly or quite half as long as hind metatarsus.

First tergite parallel-sided except for the short portion before spiracles which narrows somewhat to the base, nearly 1½ times as long as broad at apex, the surface smooth and polished basally but weakly punctate rugulose on posterior half, and there with a poorly defined median longitudinal area that is rugulose; second tergite three times as wide as long at the middle, about two-thirds as long as third, and, like all the following tergites, smooth and shining; ovipositor sheath a little longer than abdomen or hind tarsus; ovipositor decurved at apex.

Black; palpi pale; antennae entirely black; tegulae and wing bases transparent, pale yellowish; costa yellow; stigma hyaline, weakly margined with brown; metacarpus brown; all coxae black; remainder of legs reddish yellow, with hind trochanters basally, apices of hind femora and of hind tibiae, and the hind tarsi blackish.

Male: Essentially like the female.

Cocoon: Single, pure white, about 6 or 7 mm. long.

Type: USNM 63072.

Type locality: St. Augustine, Trinidad, British West Indies.

Described from 6 females and 7 males reared from larvae of an unidentified species of the pyraustid genus *Megastes*, in February 1943, by A. M. Adamson.

Apanteles paradoxus, new species

Figure 2,*d*

This new species is remarkable for having a distinctly areolated propodeum and at the same time a subexserted ovipositor and a very large, rectangular, coarsely sculptured second tergite. It somewhat resembles *Apanteles aletiae* Riley, a parasite of *Alabama argillacea* (Hbn.) and *Gonodonta nutrix* (Cram.) in the West Indies and southeastern United States, but may be immediately distinguished from that species by its unusually prominent propodeal carinae and by its very large, posteriorly broadening, and closely rugulose first tergite.

Female: Length about 2.3 mm. Face smooth and shining, with only indistinct punctation; malar space much longer than clypeus; vertex smooth and shining; temple with an impunctate and polished band directly behind eye, shallowly punctate and subopaque behind this; antennae longer than the body.

Thorax stout, about as high as broad; mesoscutum dull and with large, closely placed but clean-cut punctures that are not confluent; furrow at base of scutellum deep, strongly foveolate; disc of scutellum a little convex, polished, impunctate or with a few very shallow punctures; polished area on lateral face of scutellum semicircular, the large area in front of it longitudinally rugose; propodeum areolated, the areas defined by prominent carinae, the two basal areas smooth at base, the broad pentagonal areola and the two large apical areas rugose; mesopleuron smooth and polished except anteriorly where it is closely, strongly punctate and dull, posterior groove very finely foveolate; metapleuron polished on anterior half, rugulose and dull on posterior half; posterior coxa mostly smooth and shining but with some scattered distinct punctures and with an elongate, flattened, punctate area on outer upper edge at base; inner calcarium of hind tibia longer than outer and about half as long as basitarsus; metacarpus longer than stigma; first abscissa of radius slightly longer than intercubitus, a little curved and not strongly angled at the point of junction with it.

Abdomen short and broad; first tergite very large, broadening steadily toward apex, as broad at apex as long, strongly rugulose, and with a narrow median longitudinal fovea beyond the middle; second tergite about as long as third, about three times as broad as long and completely, strongly, longitudinally rugulose; second suture sharp and straight; third and following tergites combined about as long as first, impunctate, polished; hypopygium not projecting beyond apex of last tergite; ovipositor sheath barely exserted.

Black; palpi pale; labrum and mandibles dark brown; scape yellowish brown beneath, otherwise antenna brownish black; tegulae and wing bases yellowish brown; wings hyaline, stigma and veins light brown; anterior and middle legs entirely yellowish except for the black coxae and slightly dusky tarsi; hind coxae black; hind trochanters light brown; hind femora mostly piceous; hind tibiae blackish on distal two-thirds, pale on the basal third; hind tarsi dark brown.

Male: Like the female in all significant particulars.

Cocoons: Pure white, and gregarious but not embedded in a mass of silk.

Type: USNM 63073.

Type locality: Paso Ancho, San Sebastian, Costa Rica.

Described from 28 females and 2 males reared by C. H. Ballou in November and December 1936 at the type locality from a larva of a

notodontid, apparently a species of *Hemiceras*, on *Inga roussoviana*, and 60 females and 16 males reared from *Hemiceras* sp. "on Inga coffee tree," at Santa Tecla, El Salvador, by Paul A. Berry.

Apanteles schini, new species

FIGURE 4,*d*

This new species is exceedingly like the Nearctic *Apanteles paleacritae* Riley, a parasite of the cankerworms, but differs in having the punctures of the mesoscutum definitely sharper and even anteriorly not contiguous, in the more coarsely sculptured propodeum and first tergite, and in the nearly straight nervellus.

FEMALE: Length about 2.3 mm. Frons and vertex smooth and shining; face about as wide as eye height, indistinctly punctate and subopaque; malar space considerably longer than clypeus; antennae about as long as the body.

Mesoscutum uniformly covered with distinct, separated punctures, shining; prescutellar furrow foveolate laterally, not distinctly so medially; disc of scutellum smooth and shining but with a few scattered punctures; propodeum more declivous than in *A. paleacritae*, finely rugulose except in the large lateral apical areas which are smooth and shining; apical lateral angles of propodeum not projecting at all caudad; mesopleuron smooth and polished except anteriorly where it is weakly punctate and subopaque; metapleuron smooth and shining; radius much longer than intercubitus; nervellus oblique but virtually straight and not curved behind toward base of wing as in *A. paleacritae;* hind coxae very large, twice as long as propodeum, smooth and shining, and with a conspicuous elongate, flattened, punctate area on outer upper edge toward base; inner calcarium of middle tibia a little longer than middle metatarsus; inner calcarium of hind tibia much longer than outer and much more than half as long as hind metatarsus.

Abdomen not more than half as wide as thorax and conspicuously compressed apically; first tergite broadening very slightly caudad, nearly twice as long as broad at apex, closely and finely rugulose; second tergite with its median plate set off laterally by deep, posteriorly divergent furrows, almost as long as broad at base, distinctly broader at apex than long, the surface finely rugulose laterally and behind, smooth medially and toward base, sometimes largely smooth and shining; third and following tergites entirely smooth and polished, with no suggestion of punctation or other sculpture even on third; ovipositor sheath barely exserted.

Black; labrum reddish yellow; palpi pale yellow; antennae more or less brownish beneath toward bases; tegulae and wing bases yellow; wings hyaline, stigma and veins brown; anterior and middle coxae

blackish basally; hind coxae black; remainder of legs reddish yellow except for apex of hind femur, apical half of hind tibia and the hind tarsus, which are black.

MALE: Like the female in all essentials.

TYPE: USNM 63074.

TYPE LOCALITY: Guaratuba, Sao Paulo, Brazil.

Described from 39 females and 5 males reared in March 1954 by N. L. H. Krauss from larvae of an unidentified species of the butterfly family Riodinidae feeding on the Brazilian pepper tree, or Christmas-berry tree, *Schinus terebinthifolius.*

Apanteles kraussi, new species

This new species resembles *Apanteles lunatus* (Packard) but is larger and more coarsely sculptured. It differs further in having the second tergite about as long as the third and in having the hind femora black or blackish.

FEMALE: Length about 3 mm. Head shining, covered with very shallow, minute, setigerous punctures; malar space longer than clypeus or basal width of mandible; face narrower than eye height; antennae a little shorter than body.

Mesoscutum strongly convex, contiguously, and in part confluently, punctate, mat; prescutellar suture with nine or ten foveae; disc of scutellum large, convex, sculptured like mesoscutum; propodeum rugose, with a median longitudinal carina; mesopleuron closely, shallowly punctate anteriorly and below, polished in front of the posterior foveolate furrow; longitudinal impression on lower part of mesopleuron with a short, finely foveolate groove; radius much longer than intercubitus and not sharply angled with it; nervellus strongly oblique but not curved toward base of wing; hind coxa punctate rugulose, and dull; inner calcarium of hind tibia barely longer than outer and less than half as long as hind metatarsus.

First tergite broadening gradually caudad, about as broad on posterior margin as propodeum is long, entirely finely rugulose and dull; second tergite rectangular, twice as broad as long and about as long as third, sculptured like the first; third and following tergites smooth and shining except for a suggestion of weak roughening basally on third; ovipositor sheath barely exserted.

Black; palpi pale yellow; tegulae honey yellow; wing bases blackish; wings hyaline, stigma brown; fore and middle coxae piceous, hind coxae black; remainder of legs reddish brown, with apical segment of hind trochanter, hind femur, apex of hind tibia, and the hind tarsus more or less blackish.

MALE: Like the female in all essential respects.

COCOON: Single, buff in color.

Type: USNM 63075.

Type locality: Cuernavaca, Mexico.

Described from 12 females and 17 males reared by N. L. H. Krauss in June 1945 from *Morpheis ehrenbergi* Geyer. I take pleasure in naming this species for Mr. Krauss, who has contributed extensively to our knowledge of the habits and host relations of Braconidae.

Genus *Gnaptodon* Haliday

Gnaptodon minutus (Ashmead), new combination

Liophron [sic] *minutus* Ashmead, Journ. Linn. Soc. London, Zool., vol. 25, p. 132, 1894.

The type, from St. Vincent, which I saw some years ago in the British Museum, is a *Gnaptodon* which has lost the second intercubitus. I have observed, from material in the U. S. National Museum, that in very small specimens of this genus the second intercubitus sometimes drops out.

Genus *Opius* Wesmael

Opius capsicola, new species

Figures 1,*h*; 3,*e*

This species belongs in the *cereus* group. Structurally it is virtually identical with *Opius cereus* Gahan, but it even more closely resembles *O. fluminensis* Costa Lima, agreeing with that species and differing from *O. cereus* in its definitely infuscated wings and piceous posterior legs. It may be distinguished from *O. fluminensis* by the more or less extensive blackish markings of vertex, frons, and face, by the conspicuously yellow apex of stigma, and by the absence of black markings on the apical abdominal segments of the female.

Female: Length about 5 mm. Head as broad as thorax; temple not receding; malar space distinctly longer than basal width of mandible or median length of clypeus; face smooth except for scattered weak punctures each side of middle line; lower margin of clypeus bisinuate; a distinct opening between clypeus and mandibles; ocellocular line nearly three times as long as diameter of an ocellus; antennae a little longer than body, usually 48- to 55-segmented.

Thorax stout; notaulices strongly impressed, smooth; middle lobe of mesoscutum prominent; scutellar sulcus deep and long, and divided by a median, longitudinal keel; propodeum areolated, the carinae strong, as in *O. cereus* and *O. fluminensis*; mesopleuron without a furrow; first abscissa of radius shorter than greatest width of stigma; second abscissa about as long as first intercubitus; radial cell not attaining extreme apex of wing; recurrent vein usually interstitial with first intercubitus; nervulus very slightly postfurcal; radiella

wanting; mediella much longer than lower abscissa of basella; postnervellus distinct; second segment of posterior tarsus not longer than fifth.

Abdomen stout, smooth, and polished; first tergite with a large, nearly parallel-sided, embossed area which is margined by prominent keels that are obsolescent apically; ovipositor sheath much longer than the abdomen.

Honey yellow; vertex, frons, and middle of face more or less extensively piceous; antennae entirely black; apices of mandibles black; palpi pale yellow; wings rather strongly infumated; hind legs piceous, coxa above and more or less of apical half of femur testaceous.

Male: Like female except in having head more extensively black and apical tergite black.

Type: USNM 63076.

Type locality. El Cermeno, Panama.

Described from 61 specimens reared by James Zetek on Nov. 21, 1939, from puparia of a species of *Anastrepha* in seed capsules of *Manihot esculenta* under Zetek No. 4618. Presumably the hosts were either *Anastrepha pickeli* Costa Lima or *A. montei* Costa Lima, or both.

Opius toxotrypanae, new species

Figures 1,*f*; 2,*h*

Structurally, this new species is very similar to *Opius crawfordi* Viereck, but it is readily distinguished from that species by its black thorax.

Female: Length about 7.5 mm. Face much broader than long, distinctly, finely punctate, and with a short and broad median keel just below antennae; clypeus weakly punctate, its anterior margin acutely toothed at the middle; a distinct opening between clypeus and mandibles; malar space at least as long as median length of clypeus and longer than basal width of mandible; temple fully two-thirds as wide as eye and not receding; ocellocular line not distinctly three times as long as diameter of an ocellus; antennae longer than body, 56-segmented in the type.

Mesoscutum polished; notaulices sharply impressed anteriorly, obliterated behind; middle lobe of mesoscutum with two shallow impressions at anterior margin; prescutellar sulcus a large semicircular pit that is divided into two parts by a low median longitudinal septum; propodeum polished, with a median area, only the posterior part of which is defined by carinae; mesopleuron polished and without a longitudinal impression; metapleuron polished; radius arising from middle of stigma; radial cell not quite attaining wing apex; second abscissa of radius and first intercubitus subequal; recurrent vein

interstitial; mediella as long as lower abscissa of basella and on a straight line with it.

Abdomen smooth and polished; first tergite with two prominent dorsal longitudinal keels setting off a large, nearly parallel-sided, elevated, median area and extending nearly to posterior margin of the tergite; ovipositor sheath longer than the body.

Head black, extreme apex of malar space brownish yellow, tips of mandibles red, a small brownish yellow spot on each side of frons next to the eye; antennae completely black; thorax piceous black, varied with brownish, especially on mesoscutum and propodeum; propodeum sometimes entirely brown, or even yellowish; legs black, each leg with the apex of the second segment of trochanter and the extreme base of femur yellowish or reddish; anterior and middle tarsi pale except the apical segments; wings deeply infumated, stigma reddish brown except at base, its extreme base and veins of basal part of wing blackish; abdomen entirely yellow; ovipositor sheath black.

Male: Differs in no significant respects from the female.

Type: USNM 63077.

Type locality: Santa Engracia, Tamaulipas, Mexico.

Host: *Toxotrypana curvicauda* Gerstaecker.

Described from 14 female and 7 male specimens reared from the above host at the type locality by M. McPhail in 1936.

Opius aldrichi, new species

Figures 1,*a*; 3,*f*

This new species is distinguished particularly by the conspicuous transverse areas of contrastingly pale color before and behind the third, fourth, and fifth abdominal sutures and by the unusually slender legs.

Female: Length about 2.5 mm. Head a little wider than thorax, entirely smooth and polished; face a little wider than long; anterior margin of clypeus recurved, very gently arched; a very narrow, inconpicuous opening between clypeus and mandibles; malar space barely as long as median length of clypeus and a little shorter than basal width of mandible; temple gradually receding, about half as wide as eye; vertex slightly convex; ocellocular line at least three times the diameter of an ocellus; antennae very slender and much longer than the body, 40-segmented in the type; basal segment of flagellum much longer than the second and more than three times as long as thick; all flagellar segments longer than broad.

Thorax a little higher than wide; notaulices impressed for a very short distance, completely wanting behind the anterior third of mesoscutum; mesoscutum without a posterior discal fovea, completely

polished; scutellar furrow with eight or ten small pits; scutellum polished and rather flat; propodeum closely rugulose over its entire surface; mesopleuron with a small, shallow, nonfoveolate impression below; metapleuron polished; legs very slender; fourth segment of posterior tarsus nearly twice as long as broad; inner calcarium of posterior tibia more than one-third as long as metatarsus; radius arising from before middle of stigma, its first abscissa only one-fourth as long as first intercubitus, the second gradually thinner toward apex and much longer than first intercubitus, the third slightly arched and going to extreme wing apex; last two abscissae of cubitus subequal; recurrent vein interstitial; nervulus postfurcal by nearly its own length; second discoidal cell closed; mediella a little shorter than basal abscissa of basella and at least three times as long as nervellus.

Abdomen as long as head and thorax combined; first tergite about twice as broad at apex as at base, with two low subparallel dorsal ridges bounding a long median area that narrows gradually on apical third; surface of tergite mostly smooth with a little longitudinal roughening adjacent to dorsal ridges on apical half; remaining tergites smooth and polished; the apical margins of the third to the sixth tergites and the basal margins of the fourth to the sixth apparently more weakly sclerotized, these areas usually broadened medially and greatly narrowed at the lateral margins of the tergites; seventh tergite entirely weakly sclerotized; ovipositor sheath about half the length of abdomen, shorter than posterior tibia.

Head black; malar space, clypeus, mandibles except apices, and scape yellow; some rufous shadings around margins of eyes and about antennal foramina; antennal flegellum brownish yellow on basal three-fifths with the apical margins of the segments blackish, black on apical two-fifths; thorax black, prosternum pale brown; tegulae pale yellow; wings hyaline, veins and stigma pale brown; legs entirely yellow except base of posterior tibia and the posterior tarsus, which are dusky; dorsum of abdomen black except on the more weakly sclerotized parts adjoining the third, fourth, and fifth sutures, which are yellowish white; venter of abdomen yellowish white with a row of conspicuous black spots on each side; ovipositor sheath black.

MALE: Like the female in all essential characters.

TYPE: USNM 63078.

TYPE LOCALITY: Antigua, Guatemala.

Described from three specimens of each sex collected May 1 and May 2, 1926, by J. M. Aldrich.

Opius auripennis, new species

This new species very closely resembles *Opius cereus* Gahan, but it differs in the color of the wings. These are definitely yellow except

for the narrow apices of the anterior pair, which are contrastingly infuscated.

Female: Length about 5 mm. Face nearly twice as broad as long, weakly punctate, malar space much longer than clypeus or basal width of mandible; clypeus smooth, its anterior margin bisinuate; a distinct transverse opening between clypeus and mandibles; ocellocular line about three times the diameter of an ocellus; temples about half the eye width, not receding; antennae noticeably longer than body, about 60-segmented in the type.

Thorax short and compact; notaulices smooth, complete, meeting in a broad polished impression; middle lobe of mesoscutum noticeably elevated; scutellar sulcus deep, divided into two large pits by a median septum; propodeum areolated, with a short median basal carina followed by an elongate median area which narrows posteriorly; mesopleuron polished, with a short, shallow, smooth, longitudinal impression; stigma emitting radius from slightly beyond its middle; first intercubitus a little longer than second abscissa of radius and about three times as long as the first abscissa of radius; recurrent vein interstitial; radial cell not attaining extreme apex of wing; last abscissa of radius more than twice as long as first and second abscissae combined; mediella fully as long as basal abscissa of basella; postnervellus weak but distinct.

First abdominal tergite polished, with a large median elevated area defined by two prominent longitudinal keels that extend nearly to the apex of the tergite; remainder of abdomen smooth and shining; ovipositor sheath nearly as long as the body; hypopygium prominent.

Honey yellow; antenna completely black, including scape and pedicel; posterior tibia blackish on apical third; posterior tarsus a little infuscated; wings yellow, apex of anterior wing fuscous; stigma and veins yellow; ovipositor sheath blackish.

Male: Essentially like the female.

Type: USNM 63079.

Type locality: La Campana, Panama.

Described from two females and three males. The two females and two of the males were reared from *Anastrepha serpentina* (Wiedemann) in *Calocarpum mammosum* in August 1936 by James Zetek, under his No. 3714; the remaining male was reared from the same host at Río Abajo near Panama City in April 1935, under Zetek No. 3475.

Opius zeteki, new species

This new species closely resembles *Opius auripennis*, which is described above; however, it is immediately distinguished by its mostly black head and its blackish femora. It is also very similar to *O.*

crawfordi Viereck, but it may be at once separated from that species by the color of its wings.

FEMALE: Length about 5.5 mm. Face about twice as broad as long with minute scattered punctures; malar space slightly longer than basal width of mandible; clypeus subtriangular, its apical margin bisinuate; a rather large opening between clypeus and mandibles; temple very slightly receding, about half as wide as eye; ocellocular line at least three times diameter of an ocellus; antennae a little longer than the body, tapering slightly to apex, 59-segmented in the type.

Notaulices smooth, complete, meeting in a broad shallow depression; scutellar furrow divided into two large pits by a median longitudinal septum; propodeum areolated, with a short basal median longitudinal carina which is followed by a long narrow area extending to posterior margin; lateral longitudinal carinae complete, very prominent, and strongly bowed outwardly on posterior half of propodeum; a short basal transverse carina extending from base of the median area on each side to the lateral carina; mesopleuron with a very weak, smooth, longitudinal impression; radius arising from middle of stigma; second abscissa of radius not longer than intercubitus; recurrent vein interstitial; mediella slightly longer than basal abscissa of basella; postnervellus distinct.

Abdomen narrow at base, broadening to apex of third tergite, polished; first tergite with two prominent dorsal longitudinal keels that nearly attain posterior margin and set off a large parallel-sided area; ovipositor sheath very nearly or quite as long as the body.

Honey yellow; head black with the part below the lower level of the eyes constrastingly yellowish white; tips of mandibles black; antennae black, brownish black basally; anterior and middle coxae and trochanters, also their tibiae and tarsi, pale yellow; anterior and middle femora except at the extremities brownish black; posterior leg brownish black, second segment of trochanter mostly pale yellow, basal two-thirds of tibia concolorous with the body, tarsus weakly infuscated; wings yellow including veins and stigma, apex of anterior wing contrastingly infumated; ovipositor sheath brown to blackish.

MALE: Like the female except in having the dark color of the anterior and middle femora a little less extensive.

TYPE: USNM 63080.

TYPE LOCALITY: La Campana, Panama.

Described from 14 females and 4 males reared by James Zetek from *Anastrepha fraterculus* (Wiedemann) in *Psidium guajava*, and a series of 7 females and 2 males labeled "ex *Anastrepha striata* and *fraterculus*, La Sabanas, Panama City, J. Zetek Coll." I take pleasure in naming this interesting and attractive species in honor of Mr. Zetek, who has

reared many species of *Opius* and has contributed much valuable material in this genus to the U. S. National Museum.

Opius divergens, new species

FIGURES 1,*b*; 3,*b*

This new species is structurally almost identical with *Opius vierecki* Gahan. It is readily distinguished from that species, however, by its largely black thorax and darker legs.

FEMALE. Length 4.5 mm. Head a little narrower than thorax, strongly transverse, the temples narrow and receding; face smooth and shining, only a little broader at insertion of antennae than long; eyes very large, diverging below; clypeus only half as long as basal width of mandible and about as long as malar space, its anterior margin not sinuate or toothed; a large opening between clypeus and mandibles; ocellocular line not distinctly twice as long as the diameter of an ocellus; antennae longer than the body, 55-segmented in the type.

Thorax stout; mesoscutum polished; notaulices sharply impressed but extending only one-third the distance to posterior margin of mesoscutum; a conspicuous, somewhat elongate, median, dimple-like impression on mesoscutum posteriorly; prescutellar sulcus usually divided into four distinct pits; scutellum broader at base than long, completely polished; propodeum more or less areolated, with a rather conspicuous, somewhat irregular, arched, basal transverse carina, a median area broadening caudad and a large lateral area each side of this; mesopleuron polished with a well defined oblique foveolate impression anteriorly; radius arising from before middle of stigma; second abscissa of radius more than three times as long as first and considerably longer than first intercubitus; third abscissa of radius sinuate, ending in extreme apex of wing; recurrent vein joining second cubital cell; nervulus interstitial; mediella definitely shorter than basal abscissa of basella; postnervellus absent.

Abdomen smooth and polished; first tergite about as broad at apex as long, with two prominent dorsal keels, originating at base, converging gradually as far as middle and then parallel for a short distance, obliterated before apex of tergite; two weaker carinae, one originating on the inner side of each of those keels at the middle of the tergite, converging posteriorly, and sometimes uniting to form a short median keel; ovipositor sheath straight, about as long as the second and following tergites combined.

Head black; malar space, clypeus, and the mandibles except tips yellowish brown; antennae entirely black; thorax blackish with the pronotum anteriorly, scutellum, propodeum, and metapleura brownish to yellowish, the propodeum and metapleura being the palest; wings

strongly infumated; stigma and veins dark brown; legs including the coxae brownish black; abdomen yellow, a fuscous mark on first tergite between the apical third of the dorsal keels; ovipositor sheath black, brownish toward apex.

MALE: Like the female in all important details but with the coxae more conspicuously yellow at bases.

TYPE: USNM 63081.

TYPE LOCALITY: Tamaulipas, Mexico.

HOST: A dipterous larva in persimmon.

Described from 9 females and 11 males reared in May 1936 by M. McPhail.

Genus *Phaenocarpa* Foerster

Phaenocarpa anastrephae, new species

FIGURES 1,*e*; 3,*c*

This species differs conspicuously from other species of *Phaenocarpa* known to me by its incomplete notaulices, by its relatively large eyes, by the absence of nervellus, and by having the first brachial cell very weakly defined posteriorly and distally.

FEMALE: Length about 3 mm. Head a little broader than thorax, smooth and shining; face more than twice as wide as long; mandibles broadening apically, the median tooth acute, the lateral teeth broadly rounded off; eyes large, nearly circular in outline, more than twice as wide as the temples; antennae more than 1½ times as long as the body, very slender, 39-segmented in the type, the first flagellar segment a little thickened basally and about half as long as the second, which is much the longest segment; ocellocular line not more than half the diameter of an eye; postocellar line not distinctly as long as diameter of an ocellus.

Thorax compact; notaulices distinct anteriorly, obsolescent posteriorly; a median dimple-like impression on mesoscutum posteriorly; mesopleural furrow curved, foveolate; propodeum largely smooth and shining and with a short basal median carina followed by a narrow, carinately margined, median, longitudinal area; propodeal spiracles small; legs slender, posterior femur weakly thickened toward apex, posterior tibia somewhat curved; radius arising from beyond middle of the rather narrow stigma and going to extreme apex of wing; first abscissa of radius very short, second about twice as long as first intercubitus; cubitus nearly attaining wing margin; second abscissa of cubitus more than half as long as recurrent; subdiscoideus interstitial; hind wing very narrow, radiella incomplete, nervellus wanting.

Abdomen somewhat narrower than thorax, more or less compressed; first tergite longitudinally aciculate, with two nearly complete, posteriorly convergent keels; remainder of abdomen smooth and shining;

hypopygium large but barely extending as far posteriorly as apex of last tergite; ovipositor sheath very slender, a little shorter than thorax and abdomen combined.

Yellow; stemmaticum black, and a fine median longitudinal line extending from stemmaticum across vertex and occiput to the neck also black; scape, pedicel, and base of first flagellar segment yellow; remainder of antenna dark brown except for a subapical yellowish white annulus covering six to eight segments; posterior tibia and tarsus more or less brownish black; wings hyaline; stigma and veins brown.

Male: Differs in no essential detail from the female, although the apex of the abdomen is blackish, and the antennal annulus is narrower or even wanting.

Type: USNM 63082.

Type locality: La Campana, Panama.

Described from 36 females and 42 males reared at the type locality "from *Anastrepha* in *Spondias nigrescens*" by J. Zetek in 1937, and 16 females and 10 males, reared from *Anastrepha mombinpraeoptans* Sein, Taboga Island, Panama, by Mr. Zetek in October 1938.

Leurinion,[4] new genus

Distinguished from the known genera of Hormiini by the absence of any trace of an occipital carina; and from *Hormius* Nees, which it most closely resembles, it differs further in having the prepectus immargined and the subdiscoideus arising from about the middle of the outer end of the first brachial cell.

Head transverse; eyes large, protruding, bare; temples very narrow, receding strongly; a distinct circuliform cavity between clypeus and mandibles; occiput gently convex, immargined. Prepectus immargined; prescutellar furrow wide, propodeum with a complete median longitudinal carina; forewing with three cubital cells; radial cell large, extending to apex of wing; first brachial cell closed, emitting subdiscoideus from about the middle of its outer end; radiella wanting. First tergite widening caudad, with two large, slightly depressed areas of weaker sclerotization occupying most of the posterior half and divided by a median longitudinal keel; the following tergites largely membranous, as in *Hormius* and *Parahormius*; ovipositor short.

Type: The following new species.

Leurinion primum, new species

Figures 1,*g*; 2,*c*; 3,*g*,*h*

Female: Length about 2 mm. Head wider than thorax, smooth and polished; malar space a little longer than basal width of mandible;

[4] From the Greek *leuros*, smooth, and *inion*, occiput.

ocelli minute and close together, ocellar triangle barely wider than length of ocellocular line; antennae a little longer than body, usually 20- to 22-segmented, very slender, even the segments of apical third more than twice as long as wide.

Mesoscutum rather flat, covered with minute, very shallow, closely placed punctures; notaulices sharply impressed anteriorly but vanishing before middle of mesoscutum; furrow at base of scutellum broad and deep, not foveolate; scutellum rather flat, smooth and polished; mesopleuron polished, without a longitudinal furrow below; propodeum smooth and polished but with a strong, median longitudinal carina; legs very slender; shorter spur of hind tibia very short and not easily seen, longer spur barely as long as apical width of tibia; second abscissa of radius a little longer than first and nearly or quite as long as first intercubitus; recurrent interstitial or barely entering second cubital cell; nervulus interstitial or slightly postfurcal; nervellus very short; postnervellus wanting or faintly indicated by a short backwardly directed stub.

Abdomen at widest point about as wide as thorax; ovipositor sheath about half as long as hind femur.

Yellow with antennae and mesoscutum more or less piceous; wings clear hyaline, stigma hyaline, veins pale; legs pale yellow.

Male: Essentially like the female.

Type: USNM 63083.

Type locality: Piura, Peru.

Described from 35 females and 10 males reared by P. A. Berry on Aug. 25, 1945, from cotton buds.

Genus *Oncophanes* Foerster

Oncophanes mexicanus, new species

This new species resembles *Oncophanes nigriventris* Muesebeck in having the abdominal segments beyond the third retracted and the second and third tergites forming a solid carapace. It differs from *O. nigriventris* in having the abdomen reddish yellow and completely, strongly striate.

Female: Length about 3 mm. Head as wide as thorax, smooth and shining; face as wide as eye height; malar space longer than clypeus or basal width of mandible; antennae very slender, a little shorter than body, usually 24-segmented, first flagellar segment considerably longer than second.

Mesoscutum smooth and shining; notaulices complete, very fine, meeting in a small, roughened area; disc of scutellum smooth and polished; prescutellar sulcus deep and more than half as long as disc of scutellum, divided into two large foveae by a median longitudinal septum; propodeum completely areolated, the areas smooth and

shining with only occasional weak and short rugae, the areola pentagonal; mesopleuron with a rugulose area in upper anterior angle, beneath tegula, otherwise smooth and polished except for a short longitudinal foveolate furrow below; metapleuron rugulose; radius issuing from middle of stigma; first abscissa of radius about half as long as the second abscissa, which is slightly longer than first intercubitus; recurrent vein interstitial with first intercubitus; nervulus postfurcal by about its length; radiella represented by a short spur.

Abdomen in widest part as broad as thorax; first tergite broadening gradually caudad, about as broad at apex as long, striate on a granular surface, spiracles prominent; second and third tergites fused, the suture wanting or indicated only laterally, entirely striate on a granular surface; fourth and following segments completely retracted; ovipositor sheath very slender, about as long as hind femur.

Head and thorax black; clypeus and mandibles reddish brown; antennae brownish black with scape and pedicel more or less reddish yellow; tegulae and wing bases yellow; wings hyaline, stigma and veins brown; legs including all coxae yellow, the apices of the hind tibiae and the hind tarsi infuscated.

Male: A little smaller and more slender; otherwise like the female.

Type: USNM No. 63084.

Type locality: Cuernavaca, Mexico.

Described from 15 females and 1 male reared from a lepidopterous larva on *Eupatorium adenoptorum* by N. L. H. Krauss in January 1945.

Genus *Percnobracon* Kieffer

Percnobracon secundus, new species

Figures 1,*d*; 4,*a*,*b*

I have not seen the genotype and only described species of *Percnobracon* Kieffer, which appears to belong in the Hecabolini, but the present species is apparently congeneric although it differs from the original description of *P. stenopterus* Kieffer in several significant respects and is clearly a different species. The antennae are 16- to 18-segmented instead of 21-segmented as in the genotype; the anterior margin of the mesoscutum is not rounded but rather truncate and subangulate laterally, while the complete median furrow of the mesoscutum ascribed to *P. stenopterus* is lacking in this new species; and the propodeum is not gradually declivous as it is said to be in *P. stenopterus* but has a nearly horizontal dorsal face which is separated from the abrupt vertical face by a straight carina.

Female: Length about 2.5 mm. Head transverse but at least half as long as wide as seen from above, completely carinately margined behind; eyes slightly divergent below; malar space as long as

antennal scape; face, frons, and vertex finely rugulose striate, the striae transverse; occiput transversely striate; temples and cheeks finely aciculate; opening between clypeus and mandibles small, circular; antenna much shorter than the body, slender, filiform, 16- to 18-segmented, the first and second flagellar segments the longest and subequal.

Thorax short and compact; prepectus margined by a strong carina; mesoscutum finely alutaceous and with a few longitudinal ridges medially on posterior half; notaulices absent except for weak indications just behind the lateral angles of the anterior margin of the mesoscutum; furrow at base of scutellum broad and deep and provided with several longitudinal septa; disc of scutellum subtuberculate, small; dorsal face of propodeum rectangular, defined laterally and posteriorly by low carinae, very delicately irregularly sculptured; abrupt posterior face of propodeum smooth and shining; mesopleuron delicately alutaceous and with a sharply impressed longitudinal furrow below; metapleuron smooth and polished; hind coxa not angulate at base below; calcaria of posterior tibia very short; venation of forewing as illustrated; the first discoidal cell with numerous long bristles; hind wing lacking radiella, cubitella, and nervellus; subcostella incomplete.

Abdomen petiolate; first segment strongly arched, about half as wide at base as at apex, its apical width less than half its length, its surface weakly longitudinally wrinkled posteriorly, the spiracles prominent and situated at about the middle of the segment; confluent second and third tergites broadening caudad, at apex broader than thorax, finely longitudinally aciculate each side of the middle, the aciculations extending beyond the middle; remainder of abdomen smooth and polished; ovipositor sheath very slender, about as long as propodeum and abdomen combined.

Dark brown to piceous, antenna yellowish on basal half; abdomen black toward apex; anterior wing fuscous with two complete transverse hyaline bands, a broad one basad of first discoidal cell and a narrower one across base of stigma and base of first cubital cell; narrow outer margin and also base of the wing behind medius hyaline; hind wing entirely clear hyaline.

Male: Agrees with female in all significant respects.

Type: USNM 63085

Type locality: Piura, Peru.

Described from 8 females and 6 males reared by Paul A. Berry from an unknown host, thought to be either lepidopterous or bruchid, in pods of a species of *Caesalpina*.

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NORTH AMERICAN COPEPODS OF THE FAMILY NOTODELPHYIDAE

By Paul L. Illg [1]

Introduction

The notodelphyid copepods are almost universally inhabitants of the body cavities of ascidians. Correlated with this specialized mode of existence is the elaborate series of structural modifications displayed by these organisms. Preservation of fundamental characteristics, in spite of a high degree of adaptive radiation, renders the group a well-defined natural unit. The members of this family are poorly known, however, over the greatest extent of their occurrence and information concerning North American representatives is particularly meager. Despite their interesting biological features, these ascidicoles have been neglected by the taxonomist and ecologist alike.

To the specialist on copepods the principal limitation on availability of notodelphyids is the obvious fact that their occurrence is dependent upon that of the host organisms. The methods of obtaining and working over ascidians do not form a usual part of the operations of workers on the copepods. Considering the significant biological implications of the ascidicoles, they have received little notice from the specialists on ascidians. It is rare to chance upon a note in the

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literature on ascidians that even mentions these almost constantly present associates.

The record of these organisms, from the standpoint of world distribution, is equally scanty. The only outstanding faunistic records are provided by the excellent knowledge available of occurrence of ascidicoles on the coasts of the Scandinavian countries and on the Mediterranean shores of Europe.

As a result of the lack of distributional knowledge and ignorance of the majority of extant forms, the systematics of this group is in a very undeveloped state. The scattered references to the group have never been brought together on a large scale. The neglect of the ascidicoles is undoubtedly at least partially due to the fact that both they and their hosts have distinctly minor practical or economic importance. The worker on the copepods thus is confronted first with the problem of obtaining host material, and then with the even greater difficulty of obtaining valid determinations of the host species.

No large-scale work has been published on the North American notodelphyids. The records available from this area, including Greenland, are from the reports of Blake (1933), Gray (1938), Hansen (1923), Henderson (1931), Herdman (1898), Huntsman (1912), Pearse (1947, 1952), Stephensen (1913), and Wilson (1920, 1932, 1935a, 1935b).

The present material has been available from the most diverse situations in North America. Although the primary aim has been the establishment of the North American representation of the family Notodelphyidae, a thorough study along these lines has required careful perusal of the records of world distribution. Since this is the first time a compilation of such extent has been available, the opportunity is taken of presenting a bibliography of the notodelphyids and synonymies of the species. References compiled in the bibliography are all those which were thought significantly to affect taxonomic evaluation or provide definite information as to distribution. Incidental references to various of the genera or species are scattered throughout the whole of the literature on copepods and complete coverage of such items was not attempted. In the listing of hosts, all the different names used by authors are presented, although it is presumed some are synonymous. Further, these are quoted as found in the literature, with such attribution of authority as provided in the reference concerned only. The task of bringing the usages involved and the identifications of hosts into accordance with the modern classification of ascidians must devolve upon a specialist in that field. There is still the need for similar treatment of the remaining families of ascidicolous copepods. It is hoped that the present attempt will

demonstrate that the project is a rewarding one in terms of the array of biological information disclosed.

In the genera not actually studied in the present work the taxonomy of the earlier workers is accepted and the scheme of G. Sars (1921) is used, supplemented, where it is incomplete, from Schellenberg (1922). However, the necessity of proposing new genera to recognize the new information concerning the anatomy of the group brought forth from the study has led to the formation of six new combinations as nomenclatural concepts. Most of the reallocations of species have involved those originally proposed in the genus *Doropygus*, which, by combining the work of Sars in 1921 and the present study, has been finally subdivided into four genera. The present study has produced records in 11 genera of 23 species, of which 14 are described as new to science.

New findings of zoogeographic interest include the rediscovery of a typical arctic species, unreported since its original description, now found in collections ranging from Point Barrow, Alaska, to the Gulf of Maine, and to the north coast of Siberia. Still another instance is the establishment of the occurrence of a long-known Mediterranean species in considerable numbers along the Gulf Coast of Florida. A large number of species seems to be entirely restricted to North America, but such findings as the above leave reason to assume that some of these species will be found to have wide distributions. The almost cosmopolitan species, *Doropygus pulex* Thorell, has been found only on the east coast of North America. Only six typically European species have so far been found in the American fauna.

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Methods

The problems of collection of notodelphyids is in the main that of obtaining quantities of ascidians, the host organisms. Ascidians are entirely marine, very few tolerating even an approach to brackish conditions. Availability of free-flowing currents of water is a prime requisite for abundance of ascidians, which are notable and conspicuous members in the aggregations of animals encrusting piers and floats. However, personal experience in the accumulation of the present series indicates that the most favorable site for obtaining infested ascidians would be bottom-dwelling beds, usually those well below the level of tidal fluctuation. Dredging is therefore the recommended procedure for collecting the hosts.

Relatively few notodelphyids inhabit compound ascidians. The few that so occur are most readily obtained by observation of the living host. There ususally is a high degree of transparency, or at least translucence, of the compound tunicate, which favors detection of the dissimilar texture, and often color, of the infesting copepod, particularly under illumination for microscopic examination. Teasing out of zooids is necessary for the capture of the forms inhabiting the branchial cavities. Teasing of the matrix or systematic slicing of the colony may produce favorable results in the search for the species that live in the common channels or lie independently in matrical cavities.

The majority of forms live within the bodies of simple, or solitary, ascidians. These may be tumbled out by wholesale slicing of quantities of ascidians. It is preferable, however, to obtain the ascidicoles by dissection of the host, which procedure assures the preservation of an ascidian specimen for taxonomic identification and yields the optimum in details of biological relationships of host and commensal or parasite.

For dissection it is necessary to orient the ascidian. If the siphons are obvious, the tunic may be slit well away from them and peeled like a rind from the enclosed body. If there is no surface landmark for orientation, the best procedure is cautious peeling to expose the body and establish the location of the siphons. The specimen then should be sectioned just to one side of the median plane, preferably by a cut of deeply inserted scissors. The median plane is established as the line passing through the siphons and the cut is arranged to

start at one siphon and end at the other, leaving the resultant halves united by the intersiphonal portion of the body. In individuals with thin tests this procedure can be accomplished by cutting directly through test and all. The body, after sectioning, may be spread open and pinned down, preferably under fluid. Exposed to view will be the inner wall of the pharynx with the mid-dorsal line running down the center. A number of commensals live in the pharynx and may be observed with the naked eye or relatively low powers of magnification. The plications of the pharynx of species of ascidians thus complicated in structure should be lifted and all the recesses exposed. To expedite search in the atrium, or peribranchial cavity, the pharynx should be separated from the mantle, preferably under a dissecting microscope, by lifting it at the edges and severing the many small vascular strands that connect it to the mantle lying below. Since the number and arrangement of the principal vessels making up the pharynx wall are of systematic importance, care should be taken to prevent damage to them. The gut and gonads will be among the organs exposed in the atrial cavity. Damage to these should likewise be avoided. The wall of the stomach should be slit and the cavity investigated as a further likely harbor for copepods.

Preservation of the ascidicolous copepods is equally well achieved in formalin or alcohol. Sometimes the standard fixatives, such as Bouin's or Gilson's fluids, yield particularly well-preserved specimens. Many species can be narcotized to a state of relaxation that favors fixation by prior immersion in a small quantity of sea water upon the surface of which are floated a few drops of oil of cloves. Satisfactory results are obtained by bulk preservation of ascidians as they are collected, in standard strengths of alcohol or formalin, with subsequent exploration for the ascidicoles. Museum specimens of ascidians nearly one hundred years old have yielded copepods suitable for taxonomic identification.

For systematic determination it was found necessary to prepare microscopic dissections of the copepods. The specimens were all brought into alcohol for permanent storage. Staining was accomplished in 95 percent alcohol, first tinged distinctly yellowish with picric acid, then colored deep transparent green by the addition of a few drops of Fast Green, saturated solution in 95 percent alcohol. Staining was progressive and carried on until the setae and similar elements of ornamentation were distinctly but lightly colored. The specimens were rapidly passed through a rinse to Euparal, in which medium they were dissected with finely pointed small needles. Appendages were serially removed and each pair independently mounted under a 9×9 mm. coverslip on one 1×3 inch slide, so that the whole individual was represented on the finished single mount.

Modes of existence

The notodelphyids are most frequently restricted to the branchial cavities of the tunicates they inhabit. The members of this group show the least modification of appendages, and probably implications with regard to feeding habits might be drawn. Very evidently the food supply of the tunicate is directly shared, although there is no actual record available of the food of the notodelphyids. Representatives with most degenerated appendages come from more specialized habitats. One genus has been taken from the common cloaca of the systems of zooids of a compound ascidian. The mouthparts are so reduced in this genus that it is doubtful if the animal could ingest particulate matter. Other genera occupy such specialized sites as cyst-like cavities in the matrix of compound tunicates, cysts under the tunic of solitary ascidians, or with only the head encysted in the mesenchymal tissue of the host. The ultimate location in this line of parasitic adaptation is in cysts enveloped within the ventral blood vessel of representatives of two genera of solitary tunicates. The question of the mode of penetration of these specialized symbionts to their sites within the hosts is still unanswered. In fact, the sequence of developmental events and possible metamorphoses in the life histories of these ascidicoles is almost entirely unknown. It is obvious that much of the development in most species takes place away from association with the definitive hosts. In *Notodelphys* species several subadult stadia are passed in the body of the tunicate but this does not seem to be the case in most other genera. In many genera the males have not been found and it seems plausible to assume that they are preponderantly free-swimming. However, an additional factor must be considered before applying this conclusion. The collection and examination of the host, and the resulting unnatural and untoward conditions, may well bring about the departure of some of the associated copepods. Stock (1951) reports that slight staleness of the water in which tunicates are kept may stimulate even heavily ovigerous females of *Notodelphys* to swim forth. It may then be that males and young of most species are simply too nimble to be taken by usual means of capture in their accustomed habitat.

Of further biological interest in the existence of ascidicolous copepods is their relationship with other symbiotic organisms of the host tunicates. Della Valle has described how *Doroixys* has been taken in the branchial cavity of the zooid of a compound ascidian in which the posterior body mass of the same zooid housed an enterocolid copepod. Four or more genera of notodelphyids may actually be

represented in the symbiont assemblage in the body of a single individual solitary tunicate. In addition to notodelphyids, other copepod groups may be represented. All of the ascidicolids, buprorids, enterocolids, enteropsids, and botryllophilids are also ascidicoles. Some species of the genus *Lichomolgus* are restricted in habitat to certain tunicates. Specimens of a variety of asterocherids and of harpacticoids may occur as occasional or accidental guests of ascidians.

A notable subordinate association, frequently encountered, is the epizootic attachment of ciliate protozoans on notodelphyids. The setae of the appendages seem especially favored sites of attachment and one may often find the details of anatomy obscured by the burden of attached protozoans.

Amphipods are as commonly symbiotic with tunicates as are the ascidicolous copepods. Somewhat less commonly encountered inside tunicates, but with an actually high degree of symbiotic occurrence, are sporozoan protozoans, hydroids, flatworms, nemerteans, nematodes, polychaetes, and pinnotherid crabs. In a representative lot of tunicates assembled for the present study, a series of 20 specimens of one species was taken in a single dredge haul. Three hundred odd specimens of a species of *Doropygus* were removed from the branchial cavities. Twenty-eight amphipods (*Leucothoe* sp.) were obtained, the great majority in the atrial chambers. There were five specimens of a polychaete, both from atria and branchial baskets; and two male pinnotherids from branchial cavities completed the roster of more obvious associated animals.

The complexity of interrelationships among the ascidicolous organisms forms a most challenging ecological problem. There is virtually no record in the literature on this subject, and the possibilities from both the strictly observational and the experimental standpoints must be manifold. As a preliminary offering, here is recorded the first instance of direct impact of one of the symbiont categories upon another, for the detection of which I am indebted to Dr. Cadet Hand. A specimen of a solitary tunicate collected in Washington Sound, Washington, was found to house a number of notodelphyid copepods and a thriving colony of a hydroid, *Entocrypta huntsmani.* In one of the polyps of the hydroid was found the completely ingested body of an ovigerous female notodelphyid of very considerable bulk. Others of the same species were still thriving in the branchial chamber. What the regular food of the hydroid is no one so far has recorded, but the possibilities of complex cycles of nutritive relationships form one of the more obvious ecological corollaries of the biotic complex of ascidicolous organisms.

Family Notodelphyidae

Type genus: *Notodelphys* Allman, 1847a.

Description and morphological considerations: The family Notodelphyidae, as here considered, is defined by application of two major restrictive criteria: the development of a brood sack enclosed within the body and the occurrence of a prehensilely modified articulated hook as the terminal member of the antenna. The establishment of the homologies involved in the parasitic degradation of the various appendages in the most highly modified representatives is impossible from the meager information available. Generalities as to features of the appendages are here presented as a bare summary since species treated in extended descriptions in the succeeding part of this paper cover the full range of occurrence within the family.

The rostrum is a constant feature among the diverse array of notodelphyids. In its basic form it is an inflated cone, with little or no tendency to ornamentation.

The antennule varies from the generalized, many-segmented type like that of the most primitive cyclopoids to the bimerous or monomerous stumps of the parasites. The antenna is uniramous, a basically trimerous appendage, with relatively sparse ornamentation. The terminal armature is invariably a stout clawed articulated hook.

The development of a labrum is an almost unexceptional feature of the group. Sufficiently representative occurrences are known of the presence of paragnaths to conclude that these structures, also, are fundamentally present in notodelphyids.

Great conformity of the mouthparts is found throughout the group, except that in the parasitically degenerated extremes the homologies of these appendages are obscured. The typical mandible consists of a medially expanded basal segment and a variously ornamented palp. The maxillule consists of a masticatory basal portion with a biramous palp. The maxilla is basically pentamerous and uniramous. A very distinctive armature of medially inserted setae constitutes its principal functional component. The maxilliped is reduced, varying from trimerous to monomerous, with relatively few elements of armature differentiated.

The four pairs of swimming legs are variations upon a fundamentally cyclopoid type, bearing out the probable derivation of the group from such a free-swimming assemblage. The basic pattern consists of bimerous protopodites yoked together by an intercoxal lamella and bearing trimerous rami, the exopodite, and the endopodite. The armature consists of variously differentiated setae and spines. In the advanced parasites, the legs may be reduced to unornamented stumps.

The fifth legs are vestigial, as is typical of all the cyclopoids. The

appendage is basically a uniramous, bimerous one. The ornamentation consists at most of one to few weakly developed setae or spines. In many lines of descent within the group the fifth legs are obsolete to lacking.

Reference to the body regions of a notodelphyid as head, thorax, and abdomen is useful but throughout necessitates careful qualification. The tagmosis of the copepods presents a thorny problem and much discussion of it has appeared in print. There is a major dichotomy in the group as to the arrangement of the principal body regions. Realization of this fact plus an attempt to reconcile copepod structure with that of other major crustacean and arthropod groups has produced great ambiguity in terms of reference, and the number of schools of thought on the arrangement of the copepod body almost approaches the number of authorities who have expressed themselves. The basic disposition of the somites in copepods forms two major body regions with one additional, readily determined subdivision. There is an articulation between an anterior major mass, bearing the head structures and swimming legs, and a posterior sector with appendages insignificant to lacking. The alternatives of arrangement of this articulation delimit two principal sections of the copepods, the Gymnoplea, in which no limbs are borne on the posterior sector, and the Podoplea, which have a posterior sector bearing a pair or two of rudimentary limbs. The posterior sector, the importance of which is thus readily apparent, has been called abdomen, urosome, hind-body, and similar names, preference being shown to noncommittal expressions. The reasons for any equivocation are good ones. First, the articulation is one which does not have an exact counterpart in other major crustacean groups.

Second, the hind-body in the copepods undoubtedly has two major anatomical components. In the podopleans the first two somites are pedigerous. The second of these, further, is characterized by possession of the reproductive apertures. The conformity of these somites to the posterior thoracic segments of the majority of crustaceans is apparent. In the gymnopleans the body articulation occurs one segment posterior to the position found in podopleans. The first segment of the gymnoplean hind-body, although not pedigerous, includes the genital apertures. A thoracic series plus an abdominal series of somites thus would be seen to characterize the copepod hind-body. In females throughout the Copepoda a further complication occurs. The segment of the genital orifices usually fuses with the succeeding somite to form a compound metamere, usually exhibiting some expansion and often other elaboration. The participant elements in this complex then would seem to be one anatomically thoracic somite and one anatomically abdominal somite. As we shall

see below, however, the formation of this compound somite is not a characteristic feature throughout the notodelphyids.

In addition to the subdivision of the copepod body provided by the principal articulation, the tagmosis is further modified by the fusion of anterior segments into a cephalothoracic region, leaving several free thoracic segments anterior to the body hinge.

Finally, in *Botachus*, *Pachypygus*, and *Notopterophorus* especially, the insertion of the caudal rami is upon a complicated structure which tends to become ensheathed by the preceding abdominal segment. This reduced structure seems to be a perianal ring, and has been designated, since Giesbrecht, as the terminal abdominal segment. (In usual anatomic reference among crustacea, the perianal ring is not considered to be a true somite.)

The fundamental plan of segmentation of the body in the Notodelphyidae is exhibited in the male of *Notodelphys* spp. The major body articulation is podoplean in character. The main mass of the trunk is cephalothoracic-thoracic and it bears most of the appendages, through the fourth swimming legs. This metasomal assembly is basically 5-segmented, with the segments diverse. Nearly half the metasomal mass is the fused cephalothoracic element which supports all the head appendages and the maxillipeds. The succeeding four much-less-extensive segments each support the appropriate pair of thoracic swimming legs. The urosome, posterior to the major hinge of the body, comprises two thoracic segments and four abdominal segments (to include the telson, or perianal segment). The first urosomal segment is the fifth free thoracic segment, or the sixth limb-bearing segment attributable to the thoracic series. It supports the relatively well-developed fifth legs. The second urosomal segment, attributed by convention to the thorax, is characterized by possession of the paired reproductive apertures. These, and the segment itself, are complicated in structure by the presence of elaborate anatomical features connected with the formation of the characteristic spermatophoral capsules. The posterior ventral margin of this segment is produced into paired prominences which support two to three setae. These protrusions throughout the cyclopoid series have been long accepted as the vestiges of sixth legs (or seventh thoracic appendages).

In the males of some other genera there is also a complication of urosomal segmentation involved. This seems to be related to an extension of the structures related to the spermatophores to occupy both the thoracic somites of the urosome. The result is a more or less complete fusion of the sixth and seventh thoracic somites, with the spermatophoral capsules extending the length of the resultant segment. The sixth legs, as is usual, are prolongations of the posterior ventral margin of the structure. The fifth legs lie in rather close

apposition to the ventral surface, usually at a level about midway on the longitudinal extent. There may or may not be an obvious line of articulation in the integument of the segment at the level of the fifth legs (e. g., species of *Doropygus*, *Doropygopsis*, and *Doropygella*).

In the males of species of *Notodelphys* the segment of the fifth legs is a well-developed, freely articulated one but is intruded considerably by the spermatophoral capsules.

The majority of notodelphyid males (where they are known) conform to the above generalized plan of metasomal tagmosis. The females of the genera in which parasitic degeneration does not obscure the basic features of segmentation, in the main conform to this plan, but there are notable exceptions. The females of *Notodelphys* and, most strikingly, *Lonchidiopsis* are organized in a pattern seemingly conforming to the gymnoplean arrangement of the calanoid copepods. In *Lonchidiopsis*, an extremely aberrant notodelphyid, the bulk of the body is an expanded segment which, besides accommodating the incubatorium, supports the fourth and fifth legs; the urosome has no thoracic appendages. This tendency is also clearly seen in *Notodelphys*.

In *Notodelphys monoseta*, the last metasomal segment is the expanded incubatory complex. At its anterior articulation are borne the fourth legs; the fifth legs are set at the posterior edge and protrude posteriorly just to reach the anterior margin of the first urosomal somite. In specimens of *N. allmani* from Oban, Scotland, I find the fifth legs borne on the ventral surface of the incubatory segment, and they lie very far removed anteriorly from the hind margin of this segment.

Still further complicating the issue is the fact that the organization of the metasome in *Botachus* is very similar to that in *Notodelphys*, as was clearly shown by Kerschner in 1879. The closest affinities of *Botachus* are not readily evident but would seem to be somewhat closer to the *Pachypygus-Notopterophorus* group of forms than to *Notodelphys*. But the body is a depressed one and this very likely is the critical factor in the tagmosis. The mechanics of the articulation of the hind-body are obviously profoundly affected by the compact, depressed mass which the metasome forms.

In *Notodelphys* females there are five urosomal segments, including the so-called "segment" supporting the caudal rami; none are pedigerous. The four posterior-most are abdominal. The first, which bears the oviducal apertures, is accordingly here considered to be the seventh "thoracic" somite; it affords a most exceptional instance among copepods of this thoracic segment being free of the usual fusion with the first abdominal somite. In the species of *Doropygus* I have examined this condition also seems to exist, so that the urosome here

actually has six segments including that of the fifth legs. Other genera allied to *Doropygus* in the feature of having podoplean segmentation return to the 5-segmented urosome by accomplishing the fusion of last thoracic and first abdominal somites. This is true of *Doropygopsis* as a salient example.

The urosomal segmentation in *Notodelphys* then corresponds to the most generalized structure in the Calanoida (Gymnoplea). That in the males is of the most generalized podoplean or cyclopoid type. The mechanics of the major body articulation are complicated by the combination of effects produced by inflation of the body, with, in addition, either compression or depression markedly developed. As a result, the tagmosis in representatives of the family presents a graduated series of arrangements that spans the major subdivision in this feature, which has held as a differentiating characteristic in dichotomous arrangement of the copepods. There are both "podoplean" and "gymnoplean" notodelphyoids.

Although he did not describe the situation aptly, G. Sars (1921) was aware of a major difference in tagmosis of the female notodelphyids. He accordingly restricted the family Notodelphyidae to include *Notodelphys* (and *Agnathaner*) with "tail composed in both sexes of five segments not very different in size." He further accepted the family Doropygidae, as proposed by Brady (1878), to include 10 genera more or less closely resembling *Doropygus*, and defined, in part, by Sars as with "tail cylindrical in shape, and in most cases only composed of four distinctly defined segments." Thus, upon closer analysis, we have seen that the actual facts of the tagmosis are almost contrary to what Sars considered them.

Undue emphasis doubtless has also been placed upon the possible significance of compression and depression as major diagnostic characters in notodelphyids. A newly found species among the present material is compressed in habitus, although in all details of anatomy of the appendages it conforms to a genus in which all previously known representatives are depressed. Schellenberg (1922) was led to include in the genus *Doropygus* by their compressed habitus three species which are clearly much more closely allied to *Notodelphys* when the features of their appendages are taken into account.

As to the alternative possibilities of fusion of the segment of the first swimming legs with the head or persistence as a separate unit, as will be shown below, the records have not been consistently reliable in the past. Further, both conditions seemingly may occur in a single genus. Accordingly the bearing of this question on the higher levels of classification, in the present state of knowledge, is not clear.

The various trends of modification in the degenerated parasitic lineages within the group have further significance in the problem of

the tagmosis of the notodelphyids. A major tendency, quite obviously independently initiated in more than one of the related assemblages within the group, is the encroachment of the brood sack upon successively more of the thoracic somites until all those bearing swimming legs come to be incorporated in the incubatory structure. A second important trait is the coalescence of segments as parasitic modification advances.

The internal anatomy of the notodelphyids for the most part remains to be described. In keeping with many copepods, the members of this family lack respiratory and circulatory structures. There is no full description of the musculature of any representative available. Features of the excretory organs and of the digestive and nervous systems are known only as isolated details scattered through the references to the group.

The reproductive system was extensively studied in *Notopterophorus* by Giesbrecht (1882a), and Canu (1892) added many details from his studies on a number of forms. The typical female reproductive system of notodelphyids conforms to the general pattern found among copepods. There is a single medial ovarian mass located dorsally in the metasome. Paired oviducts traverse the body from the level of the ovary to the seventh thoracic segment, which is invariably located on the urosome as the first or second segment. The oviducts open dorsolaterally as rather elaborately developed genital atria, these frequently being shielded at the orifices by modified tegumentary structures. A seminal apparatus is also a feature of this genital somite. There is a median pore on the ventral surface, which serves as a site of attachment for the spermatophores transferred from the male in copulation. From the pore a short canal proceeds laterally on either side to the paired seminal receptacles which lie in close relation to the genital atria. From the seminal receptacles the sperm passes to the eggs in the genital atrium as they are being extruded into the brood sack. The arrangement of paired seminal reservoirs has been suggested as a possible diagnostic character of the family Notodelphyidae. It is certainly in contrast to the condition found in the genus *Cyclops* in which typically a large single median seminal receptacle is developed. However, the discernment of this anatomical feature is difficult and the condition in the majority of the Cyclopinidae, for which information would be most significant, has not so far been recorded.

The male reproductive system is less well known than the female. Canu (1892, pls. 6, 8) provided detailed illustration of this tract in two genera, and these features conform well to the generalized cyclopoid condition.

A large single testis occupies the dorsal median portion of the first three thoracic segments. It may protrude anteriorly into the hinder portion of head. A deferent duct takes its origin rather far forward on the testicular mass on either side. The duct first is arranged as a highly convoluted section, which lies opposite the anterior third of the testis, then courses directly posteriorly to the seventh thoracic somite, which is the genital segment, located in the urosome. Most of the duct seems to be highly glandular, and considerable enlargement is developed posterior to the convoluted portion. Each duct terminates in a large seminal vesicle, in which the spermatophoral capsule is elaborated. The seminal vesicles occupy most of the ventral portion of the genital segment. Each may intrude considerably into the next anterior segment of the fifth legs. The large apertures of the seminal vesicles are overlain by the protective integumentary flaps, usually bearing two setae, which are considered to be the sixth legs. The spermatophores are somehow removed from these orifices and cemented to the midventral seminal aperture of the female in the act of copulation.

Canu (1892) made an outstanding contribution in the description of developmental stadia for five species encountered by him. Unfortunately his treatment of the later stages was not recorded in terms of the criteria of modern usage and these remain to be reappraised. No subsequent life history study adding greatly to this basic information has been found in the literature search made for the present paper.

K. Lang (1949) described a new family of copepods, the Archinotodelphyidae, to include some very primitively constructed ascidicolous copepods. These would, basically, require only the anatomical modifications of provision of an internal brood sack and some slight alterations in some of the appendages to apply to a familial definition which would accommodate the series of genera herein assigned to the Notodelphyidae. They thus possess points of structure which strongly indicate that they may be a remnant of the archetypical stock which gave rise to the notodelphyids. Further, the inclusion of the archinotodelphyids within the family Cyclopinidae, a long-known group of free-living cyclopoids, would be consequent upon fairly simple transformations of a few appendages.

This demonstration of the cyclopinid-notodelphyid phylogenetic series has led to the abandonment of the traditional usage, introduced by G. Sars (1921), which considers the majority of ascidicolous copepods as a suborder, the Notodelphyoida. The Notodelphyidae, Lang shows, are directly assignable to the cyclopinid stock within the Cyclopoida. Other ascidicolous families also show cyclopinid affinities, but not so obviously. One family among them Lang has considered to have affinity with a somewhat more remotely related cyclo-

poid series, the poecilostomes, so that the suborder of former usage is held by him to have been polyphyletic.

The classification of the notodelphyid ascidicoles then has resolved as a problem in practicality. There are good grounds for joining together the families Cyclopinidae, Archinotodelphyidae, and Notodelphyidae, since the distinctions between each two adjacent families are so minor, as pointed out above. If this combination were adopted, the problem of naming the assemblage would present difficulties. The name Notodelphyidae was used so early as a familial concept that it ought to deserve a weighty claim on grounds of mere priority. However, the disadvantage of applying the name is that the very phylogenetic trend which conveys biological significance to the grouping is thereby obscured. To preserve the phylogenetic considerations it would further be advisable to retain the separate categories at subfamilial level. This outcome, it seems obvious, offers so little gain over the treatment of the groups as separate families, that this latter alternative is here accepted.

A further consideration in the arrangement of the genera concerned is the proposition by Chatton and Brément (1915b) of a family Ophioseididae to include *Ophioseides*, *Brementia*, *Ooneides*. A grouping of the notodelphyoid genera which exhibit loss of one or more mouthparts would extend this series to include also *Scolecodes*, *Scolecimorpha*, *Pholeterides*, and *Dysgenopsyllus*. All of these exhibit extreme modifications toward parasitic degeneration. However, the great reduction of the appendages makes it impossible to determine whether the same mouthpart has been lost in each. This issue is the crux of the problem of establishing the series as monophyletic, and, thereby, its validity as a taxonomic unit. Accordingly, it is here considered that the most practical treatment could not recognize the ophioseidids as a family.

The existence of the ophioseidid genera in the notodelphyid series possessing incubatoria offers a possible objection to Lang's consideration of the enterocolids as poecilostomes. By the loss of mouthparts, the ophioseidids might be considered to qualify as poecilostomes, but the derivation of these genera seems so obviously demonstrable from the notodelphyid stock that other assignment would be purely arbitrary. Since the outstanding character of the poecilostomes is this more or less negative feature and the existence of a convergent parallel is available, the question arises whether the poecilostomes are not in fact an artificial, polyphyletic grouping. There are grounds in the definitions of some of the families to offer support to this suspicion. It seems entirely possible that further discoveries among the ascidicolous copepods may yet provide the links that can connect the enterocolids to the parental gnathostome stock. The question, it would seem, should remain an open one until further facts are available.

Key to genera of *Notodelphyidae*, based upon females [2]

1*a*.	All mouthparts represented	2
1*b*.	One or more pairs of mouthparts absent	21
2*a*.	Second to fourth exopodites reduced, segmentation obsolete	3
2*b*.	Second to fourth exopodites distinctly segmented	4
3*a*.	Fifth legs absent . . . . **Prophioseides**	(p. 480)
3*b*.	Fifth legs present as reduced scales . . . . **Campopera**	(p. 480)
4*a*.	Brood sack involves second to fourth thoracic segments	5
4*b*.	Brood sack involves principally fourth thoracic segment	6
5*a*.	Fifth legs absent . . . . **Gnenotophorus**	(p. 621)
5*b*.	Fifth legs present . . . . **Bonnierilla**	(p. 480)
6*a*.	Maxilliped consists of 3 setiferous segments	7
6*b*.	Maxilliped monomerous to trimerous, at most two segments setiferous .	10
7*a*.	Body depressed . . . . **Notodelphys**	(p. 488)
7*b*.	Body compressed	8
8*a*.	Endopodites 2 to 4 bimerous . . . . **Notopterophorus**	(p. 481)
8*b*.	Endopodites 2 to 4 trimerous	9
9*a*.	Antennule 9- or 10-segmented . . . . **Doropygopsis**	(p. 591)
9*b*.	Antennule of less than 9 segments . . . . **Pachypygus**	(p. 608)
10*a*.	Armature of caudal rami variously developed setae	11
10*b*.	Armature of caudal rami variously developed clawlike spines	18
11*a*.	Basal segment of antenna with one or more well-developed plumose setae	12
11*b*.	Setation of basal segment of antenna much reduced or absent	14
12*a*.	Urosome 4-segmented . . . . **Notodelphyopsis**	(p. 511)
12*b*.	Urosome 5-segmented	13
13*a*.	Maxilliped trimerous, or bimerous with three terminal setae. **Paranotodelphys**	(p. 484)
13*b*.	Maxilliped bimerous with two terminal setae . . . . **Pygodelphys**	(p. 598)
14*a*.	Fifth leg reduced to an unarticulated scalelike structure	15
14*b*.	Fifth leg articulated, well-developed	16
15*a*.	Fifth leg rudiment setiferous . . . . **Doroixys**	(p. 484)
15*b*.	Fifth leg rudiment unornamented . . . . **Pomphopygus**	(p. 616)
16*a*.	Body depressed . . . . **Lonchidiopsis**	(p. 485)
16*b*.	Body compressed	17
17*a*.	Endopodite of maxillule with 6 or more setae . . . . **Doropygella**	(p. 590)
17*b*.	Endopodite of maxillule with less than 6 setae . . . . **Doropygus**	(p. 518)
18*a*.	Body depressed . . . . **Botachus**	(p. 485)
18*b*.	Body compressed	19
19*a*.	Endopodites 2 to 4 trimerous . . . . **Goniodelphys**	(p. 486)
19*b*.	Endopodites 2 to 4 bimerous	20
20*a*.	Antennule 8-segmented . . . . **Ustina**	(p. 486)
20*b*.	Antennule 7-segmented . . . . **Notopterophoroides**	(p. 486)

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[2] *Agnathaner* Canu, based upon males only, is omitted from this key. The resemblance of the antenna to that of *Notodelphys*, with the unique degree of reduction of the mouthparts, furnish characters for the separation of this genus from all others.

21*a*. Body an inflated ovoid . . . . **Ooneides** (p. 487)
21*b*. Body more elongate, vermiform 22
22*a*. No thoracic appendages . . . . **Ophioseides** (p. 487)
22*b*. One or more pairs of reduced swimming legs 23
23*a*. One pair of reduced swimming legs present . . **Dysgenopsyllus** (p. 487)
23*b*. Four pairs of reduced swimming legs present 24
24*a*. Swimming legs long, tapered, unsegmented processes lacking well-developed armature 25
24*b*. Swimming legs short, compact, armed with short, stout spines 26
25*a*. Mouth appendages grouped at the midline . . . . . **Brementia** (p. 487)
25*b*. Mouth appendages displaced far laterally . . . . **Pholeterides** (p. 637)
26*a*. Brood sack occupies body region posterior to second legs. **Scolecimorpha** (p. 488)
26*b*. Brood sack occupies body region posterior to fourth swimming legs. **Scolecodes** (p. 632)

Species Incerta Sedis

Doropygus cylindriformis (p. 586).

Indeterminable Genera

Salpicola (p. 640).
Ophioseidus (p. 640).

Genera not known from North America

Genus *Agnathaner* Canu

Agnathaner Canu, 1891, p. 474 (type species, by original designation, *Agnathaner typicus* Canu, 1891); 1892, pp. 210–211.—T. Scott, 1907, p. 363.—Smith, 1909, p. 66.—G. Sars, 1921, pp. 38–39.—Schellenberg, 1922, p. 224.—Wilson, 1924, p. 17; 1932, p. 598.
Agnathener Leigh-Sharpe, 1934, p. 6.

Agnathaner typicus Canu

Agnathaner typicus Canu, 1891, p. 474 (type locality, Wimereux, France, in *Cynthia rustica*); 1892, pp. 211–212, pl. 17, figs. 1–10.—G. Sars, 1921, pp. 39–40, pl. 19.—Sewell, 1949, p. 188.

Distribution: Northern coast of France, Norway.
Hosts: *Cynthia rustica, Styelopsis grossularia* van Beneden.

Agnathaner minutus Canu

Agnathaner minutus Canu, 1891, p. 474 (type locality, Wimereux, France, in *Circinalium concrescens*); 1892, pp. 212–213, pl. 17, figs. 11–26.—Hartmeyer, 1911, p. 1736.—Sewell, 1949, p. 188.

Distribution: Northern coast of France.
Host: *Sidnyum turbinatum* (?=*Circinalium concrescens* Giard).

Genus *Prophioseides* Chatton and Brément

Ophioseides Chatton and Brément, 1911, p. 30 (part).
Prophioseides Chatton and Brément, 1915c, p. 155 (type species, by monotypy, *Ophioseides abdominalis* Chatton and Brément, 1911).

Prophioseides abdominalis (Chatton and Brément)

Ophioseides abdominalis Chatton and Brément, 1911, pp. 30–33, fig. 1 (type locality, Banyuls-sur-Mer, France, in *Amaroucium densum* G.); 1915b, p. 134.—Schellenberg, 1922, p. 261.—Harant, 1931, p. 372.—Sewell, 1949, p. 183.

Distribution: Banyuls, France.
Host: *Amaroucium densum* G.

Genus *Campopera* Schellenberg

Campopera Schellenberg, 1922, p. 259 (type species, by monotypy, *C. michaelseni* Schellenberg, 1922).—Wilson, 1932, p. 602.

Campopera michaelseni Schellenberg

Campopera michaelseni Schellenberg, 1922, pp. 259–261, figs. 41–43 (type locality, Port Stanley, Falkland Islands, in *Paramolgula gigantea* (Cun.)).

Distribution: Falkland Islands.
Host: *Paramolgula gigantea.*

Genus *Bonnierilla* Canu

Paryphes Kerschner, 1879, pp. 179–182 (not *Paryphes* Burmeister, 1835) (type species, by monotypy, *P. longipes* Kerschner, 1879).—von Martens, 1879, p. 44.—Giesbrecht, 1882a, pp. 325, 326.—Carus, 1885, p. 344.
Bonnierilla Canu, 1891, pp. 470, 473, 475 (type species, by monotypy, *Paryphes longipes* Kerschner, 1879); 1892, pp. 196–197.—Schellenberg, 1922, pp. 249–250.—Wilson, 1924, p. 18; 1932, p. 599.
Bonneriella Vosseler, 1894, p. 357.—Norman, 1905, p. 36.
Bonnierella Gurney, 1927, p. 480 (not *Bonnierella* Chevreux, 1900).
Bonierilla Sewell, 1949, pp. 164, 174.

Bonnierilla acollaris Schellenberg

Bonnierilla acollaris Schellenberg, 1922, pp. 250–251, 266, fig. 29.—Sewell, 1949, p. 170 (type localities: Australia, Suez; in *Ascidia malaca* Traust., *A. glabra* Hartmr., *Ascidiella aspersa* (Müll.), *Pyura gangelion* (Sav.), *Styela canopus* (Sav.)).
Bonnierella acollaris Gurney, 1927, p. 480.
Bonnierilla acollaris Sewell, 1949, p. 174.
?*Bonnierilla scolaris* Sewell, 1949, p. 179.

Distribution: Australia; Gulf of Suez.
Hosts: *Ascidia glabra* Hartmr., *Ascidia malaca* Traust., *Ascidiella aspersa* (Müll.), *Pyura gangelion* (Savigny), *Styela canopus* (Savigny).

Bonnierilla arcuata Brément

Bonnierilla arcuata Brément, 1909, pp. 64–69, figs. 1–14 (type locality, Banyuls, France, in *Diplosoma spongiforme* Giard).—Hartmeyer, 1911, p. 1736.—Schellenberg, 1922, pp. 250, 266.—Harant, 1931, p. 370.

Distribution: Coast of France.

Host: *Diplosoma spongiforme* Giard.

Bonnierilla armata Schellenberg

Bonnierilla armata Schellenberg, 1922, pp. 252–253, 266, fig. 32 (type localities, Australia; West Africa; in *Molgula reducta* Hartmr., and *Polycarpa goréensis* Mchlsn).

B. [*onierilla*] *armata* Sewell, 1949, p. 174.

Distribution: Australia; West Africa.

Hosts: *Molgula reducta* Hartmr., *Polycarpa goréensis* (Mchlsn.).

Bonnierilla brevipes Schellenberg

Bonnierilla brevipes Schellenberg, 1922, pp. 251–252, 266, figs. 30–31 (type locality, Malay Archipelago, in *Polycarpa papillata* (Sluit.)).

Bonierilla brevipes Sewell, 1949, p. 163.

Distribution: Malay Archipelago.

Host: *Polycarpa papillata* (Sluit.).

Bonnierilla longipes (Kerschner)

Paryphes longipes Kerschner, 1879, pp. 179–182, pl. 3, fig. 10, pl. 4, figs. 1–10 (type locality, Bay of Muggia, Trieste, in *Cynthia* spp.).—Gourret, 1888, p. 1.—Graeffe, 1902, p. 40.—Sewell, 1949, p. 183.

Bonnierilla longipes Canu, 1891, p. 473; 1892, pp. 77–78, 197–198, pl. 9, figs. 4–13, pl. 10, figs. 1–8.—Norman, 1905, p. 36.—Hartmeyer, 1911, pp. 1734–1735.—Schellenberg, 1922, pp. 250, 266.—Harant, 1931, p. 370.—Sewell, 1949, p. 182.

Bonnierella longipes Gurney, 1933, p. 304.

Distribution: Mediterranean; Atlantic coast of France.

Hosts: *Clavelina lepadiformis, Cynthia lurida* Thor., *Cynthia* sp., *Pyura lurida, Pyura* sp.

Genus *Notopterophorus* Leuckart

Notopterophorus Costa, 1840, p. 7 (nomen nudum).—Hope, 1851, p. 38 (nomen nudum).—Leuckart, 1859, pp. 241–247 (type species, *N. veranyi* Leuckart, 1859).—Thorell, 1859a, p. 6; 1859b, p. 336; 1860, p. 115.—M. Sars, 1861, p. 136.—Claus, 1864, p. 381.—Buchholz, 1869, pp. 125–126.—Calman, 1909, p. 103.—G. O. Sars, 1921, pp. 52–53.—Brehm, 1927, p. 490 (part).—Schellenberg, 1922, p. 254 (part).—Wilson, 1932, p. 602.

Notopteropherus Claus, 1875, p. 350.

Doropygus (*Notopterophorus*) Giesbrecht, 1882a, pp. 316–325 (part).

Doropygus Thorell, 1859a, pp. 43–46 (part).—Aurivillius, 1882a, p. 46.

Notopterophorus auritus (Thorell)

Doropygus auritus Thorell, 1859a, pp. 50–52, pl. 7, pl. 8, fig. 10 (type locality, Sweden, in *Ascidia canina* Müll.); 1859b, pp. 339, 343; 1860, pp. 119, 123.—Hesse, 1866, pp. 54, 64.—Norman, 1869, p. 299.—Gerstaecker, 1870–1871, pp. 777, 801, pl. 11, figs. 12–22.—Brady, 1878, pp. 135–136, pl. 29, figs. 1–11.—Aurivillius, 1882a, pp. 55–56, pl. 6, fig. 13; 1882b, pp. 61, 112, pl. 13, fig. 12, pl. 15, figs. 1, 2; 1883, pp. 25–26, 57, 108, pl. 2, fig. 13, pl. 4, fig. 12, pl. 6, figs. 1, 2.—Norman, 1905, p. 36.—Norman and Scott, 1906, p. 202.—T. Scott, 1907, p. 364.—Vanhöffen, 1917, p. 224.

Doropygus (*Notopterophorus*) *elongatus* var. *auritus* Giesbrecht, 1882a, pp. 317, 328.—Carus, 1885, p. 343.—Pesta, 1909, p. 259.

Notopterophorus auritus Koehler, 1890, p. 138.—G. Sars, 1921, pp. 53–54, pl. 26.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 120, fig. 72.—Lang, 1948, p. 3.—Sewell, 1949, pp. 188, 191.

Notopterophorus elongatus var. *auritus* Schellenberg, 1922, pp. 254, 266.

Distribution: Sweden, Norway; British Isles.

Hosts: *Ascidia canina Müller*, *A. mentula*, *Phallusia mentula*, *P. obliqua*, *P. venosa*.

Notopterophorus micropterus G. Sars

Notopterophorus micropterus G. Sars, 1921, p. 56, pl. 28, fig. 1 (type locality, Norway).—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 121, fig. 74.—Sewell, 1949, p. 191.

Distribution: Norway.

Host: *Ascidia mentula*.

Notopterophorus papilio Hesse

Notopterophorus papilio Hesse, 1864, pp. 338–343, pl. 11, figs. 1–13 (type locality, France, in *Phallusia canina*); 1865, pp. 220–223.—Norman, 1869, p. 300; 1905, p. 36.—Gerstaecker, 1870–1871, pp. 776, 801.—Brady, 1878, pp. 142–144, pl. 31, figs. 3–12.—Richiardi, 1880, p. 147.—Koehler, 1890, pp. 131–134, 138, figs. 1, 4–8.—Schimkewitsch, 1893, pp. 200, 202; 1896, p. 339, pl. 14, figs. 30–32, pl. 16, figs. 56, 61.—Thompson, 1893, pp. 190–191, pl. 18, figs. 5, 6.—T. Scott, 1897, p. 148; 1901, p. 351; 1907, pp. 365–366; 1908, pp. 212–216.—Norman and Scott, 1906, p. 202.—Hartmeyer, 1911, p. 1735.—G. Sars, 1921, p. 55, pl. 27.—Schellenberg, 1922, p. 254, 267.—Harant, 1931, p. 372.—Marine Biological Association, 1931, p. 173.—Leigh-Sharpe, 1935, p. 48.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, pp. 120–121, fig. 73.—Sewell, 1949, p. 188.

Doropygus (*Notopterophorus*) *papilio* Giesbrecht, 1882a, pp. 316, 327.—Carus, 1885, p. 341.—Gourret, 1888, p. 1.—Pesta, 1909, p. 259.

Notopterophorus pupilio Hesse, 1869, p. 298.

Doropygus (*Notopterophorus*) *papilio* var. *massiliensis* Gourret, 1887, pp. 185–186; 1888, pp. 36–52, pl. 2, fig. 10, pl. 3, figs. 1, 2, 5, pl. 4, figs. 3, 4.—Sewell, 1949, p. 182.

Distribution: Mediterranean to Norway; British Isles.

Hosts: *Ascidia canina*, *A. mentula*, *Ciona canina*, *Phallusia mentula*, *P. oblique*, *P. venosa*.

Notopterophorus elongatus Buchholz

Notopterophorus elongatus Costa, 1840, p. 7 (nomen nudum).—Hope, 1851, p. 38 (nomen nudum).—Claus, 1864, pp. 381–382 (nomen nudum).—Buchholz, 1869, pp. 127–136, pl. 8, fig. 6, pl. 9, fig. 6.—Brady, 1878, p. 144.—Kerschner, 1879, pp. 187–189, pl. 1, figs. 8, 9, pl. 3, fig. 3, pl. 5, figs. 13–17, pl. 6, figs. 1, 2.—Richiardi, 1880, p. 147.—Giesbrecht, 1882a, pp. 370–371, pl. 23, figs. 2–4, 11, pl. 24, fig. 7; 1892, p. 815.—Koehler, 1890, p. 132, figs. 2, 3, p. 138.—Graeffe, 1902, p. 39.—Norman, 1905, p. 36.—Brian, 1906, p. 144.—Schellenberg, 1922, pp. 254, 266–267.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 121.—Sewell, 1949, pp. 182, 188.

Notopterophorus elongatus var. *elongatus* Schellenberg, 1922, p. 254.

Notopterophorus elatus Costa, 1840, p. 7 (nomen nudum).—Hope, 1851, p. 38 (nomen nudum).—Claus, 1864, pp. 381–382 (nomen nudum).—Giesbrecht, 1882a, pp. 370–372, pl. 22, fig. 1, pl. 23, figs. 12–14, pl. 24, figs. 8, 10–15, 18–21; 1892, p. 815.—Norman, 1905, p. 36.—Brian, 1906, p. 144.—Harant, 1931, p. 372.

Notopterophorus veranyi Leuckart, 1859, pp. 241–247, pl. 6, figs. 2–8 (type locality, Nizza, in *Phallusia mammillaris*).—Thorell, 1859a, p. 6.—Hesse, 1864, p. 338.—Heller, 1866, p. 750.—Stossich, 1881, pp. 270–271.—Hartmeyer, 1911, p. 1735.

Doropygus auritus var. *elongatus* Aurivillius, 1882b, pp. 61–70, 112, pl. 15, fig. 3; 1883, pp. 57–66, 108, pl. 6, fig. 3.

Doropygus (*Notopterophorus*) *elongatus* Giesbrecht, 1882a, pp. 316, 327.—Carus, 1885, p. 343.—Canu, 1892, pp. 190–191.—Pesta, 1909, p. 259.

Doropygus (*Notopterophorus*) *elongatus* var. *elongatus* Giesbrecht, 1882a, pp. 316, 328.—Gourret, 1888, p. 1.—Pesta, 1909, p. 259.

Doropygus (*Notopterophorus*) *elongatus* var. *elatus* Giesbrecht, 1882a, pp. 316, 327.—Carus, 1885, p. 343.—Gourret, 1888, p. 1.—Canu, 1892, p. 191.—Pesta, 1909, p. 259.

[*Doropygus*] (*Notopterophorus*) *elatus* Canu, 1891, p. 472.

Notopterophorus elongatus var. *elatus* Koehler, 1890, p. 138.—Schellenberg, 1922, pp. 254, 266.

Doropygus (*Notopterophorus*) *elongatus* var. *maculatus* Gourret, 1887, p. 186; 1888, pp. 52–59, pl. 2, figs. 11–13; pl. 3, fig. 4; pl. 4, fig. 5.

?*Notopterophorus elongatus* var. *massiliensis* Sewell, 1949, p. 182.

Distribution: Mediterranean to Sweden.

Hosts: *Ascidia mentula*, *A. mammillata*, *Ascidiella aspersa*, *Clavellina lepadiformis*, *Phallusia mamillata*, *P. mammillaris*, *P. mentula*, *P. gelatinosa*, *Phallusiopsis mammillata*.

Notopterophorus sp. Schimkewitsch

Notopterophorus sp. Schimkewitsch, 1896, p. 342, pl. 15, figs. 43, 44–46.

Distribution: Roscoff, France.

Hosts: *Ascidia sanguinolenta*, *Ciona intestinalis*.

Indeterminable Species

Notopterophorus bombyx Hesse

Notopterophorus bombyx Hesse, 1865, pp. 223–226 (type locality, coast of France, in *Ciona intestinalis*).—Gerstaecker, 1870–1871, pp. 776, 801.—Hartmeyer, 1911, p. 1735.

Genus *Paranotodelphys* Schellenberg

Paranotodelphys Schellenberg, 1922, pp. 232–233 (type, hereby designated, *P. scutiformis* Schellenberg, 1922 [first species]).—Gurney, 1927, p. 480.—Wilson, 1932, pp. 598, 599.

Pseudonotodelphys Gurney, 1927, p. 480 (type species, by monotypy, *P. phallusiae* Gurney, 1927).—Wilson, 1932, p. 590.—Lang, 1948, p. 6.

?*Notodelphys* Lang, 1948, p. 6 (part).

Paranotodelphys scutiformis Schellenberg

Paranotodelphys scutiformis Schellenberg, 1922, pp. 233–235, figs. 9–11 (type localities: Freemantle, Australia, Sharks Bay, Australia, Pajunga Islands; in *Ascidia malaca* Traust., *Ascidiella aspersa* (Müll.), *Ascidiella latesiphonica* Hartmr., *Ascidia gemmata* Sluit.).—Sewell, 1949, p. 174.

DISTRIBUTION: Australia, Pajunga Islands.

HOSTS: *Ascidia malaca* Traust., *Ascidiella aspersa* (Müll.), *Ascidiella latesiphonica* Hartmr., *Ascidia gemmata* Sluit.

Paranotodelphys gracilis Schellenberg

Paranotodelphys gracilis Schellenberg, 1922, pp. 235–236, figs. 12–14 (type locality, Gulf of Suez, in *Rhodosoma verecundum* Ehrbg.).—Gurney, 1927, p. 480.—Sewell, 1949, pp. 169, 179.

DISTRIBUTION: Gulf of Suez.

HOST: *Rhodosoma verecundum* Ehrbg.

Paranotodelphys longicauda Schellenberg

Paranotodelphys longicauda Schellenberg, 1922, pp. 236–237, figs. 15, 16 (type locality Gauss-Station, Deutsche Tiefsee Expedition, Antarktis [sic]).—Sewell, 1949, p. 174.

DISTRIBUTION: Antarctic.

Paranotodelphys phallusiae (Gurney), new combination

Pseudonotodelphys phallusiae Gurney, 1927, pp. 480–482, fig. 120,a–m (type locality, Gulf of Suez, from collections in which *Phallusia nigra* was common).—Sewell, 1949, pp. 169, 179.

DISTRIBUTION: Gulf of Suez.

HOST: Not certainly known.

Genus *Doroixys* Kerschner

Doroixys Kerschner, 1879, pp. 176–179 (type species, by monotypy, *D. uncinata* Kerschner, 1879).—T. Scott, 1907, p. 366.—Wilson, 1932, p. 601.

Doroyxes Giesbrecht, 1882a, pp. 325, 326.

Doroixys uncinata Kerschner

Doroixys uncinata Kerschner, 1879, pp. 176–179, pl. 4, figs. 11–13, pl. 5, figs. 1–12 (type locality, Trieste, in *Amaroecium* spp.).—Della Valle, 1883, pp. 242–245, pl. [1], figs. 1, 2.—Carus, 1885, p. 343.—Gourret, 1888, p. 1.—Canu, 1891, p. 472; 1892, pp. 83–88, 202–203, pl. 14, figs. 1–14, pl. 15, figs. 1–11.—Graeffe, 1902, p. 40.—Norman, 1905, p. 36.—Hartmeyer, 1911, p. 1734.—Schellenberg, 1922, pp. 254, 266.—Harant, 1931, p. 370.—Sewell, 1949, pp. 183, 184, 188.

Distribution: Mediterranean; northern coast of France.

Hosts: *Amaroecium* spp., *Aplidium cristallinum*, *Aplidium gibbulosum*, *Fragarium areolatum*, *Diazona violacea*, *Perophora listeri*, *Botrylloides* spp., *Botryllus violatinctus*, *Glossoforum luteum*, *Amaroucium gibbulosum*, *Amaroucium mediterraneum*, *Parascidia areolata*, *Sidnyum turbinatum*, *Morchellium argus*, *Polyclinum aurantium*, *Amaroucium punctum*, *Amaroucium areolatum*.

Genus *Lonchidiopsis* Vanhöffen

Lonchidiopsis Vanhöffen, 1917, pp. 224–229 (type species, by monotypy, *L. hartmeyeri* Vanhöffen, 1917).—Schellenberg, 1922, p. 259.—Wilson, 1932, p. 599.

Lonchidiopsis hartmeyeri Vanhöffen

Lonchidiopsis hartmeyeri Vanhöffen, 1917, pp. 224–229, pl. [1], text figs. 1–7 (type locality, Sharks Bay, Australia, in *Ascidia sydneiensis* Stimpson).—Schellenberg, 1922, pp. 259, 268.

Distribution: Australia.

Host: *Ascidia sydneiensis* Stimpson.

Genus *Botachus* Thorell

Botachus Thorell, 1859a, pp. 54–55 (type species, by monotypy, *B. cylindratus* Thorell, 1859a).—Claus, 1875, p. 350.—Giesbrecht, 1882a, pp. 325, 326.—Brehm, 1927, p. 490.—Wilson, 1932, p. 598.

Botachus cylindratus Thorell

Botachus cylindratus Thorell, 1859a, pp. 55–56, pl. 9, fig. 12 (type locality, Sweden); 1859b, pp. 339, 342, 343; 1860, pp. 119, 121, 123.—Norman, 1869, pp. 299–300; 1905, p. 36.—Gerstaecker, 1870–1871, pp. 775, 801.—Brady, 1878, pp. 140–141, pl. 33, figs. 1–13.—Kerschner, 1879, pp. 189–190, pl. 2, figs. 1, 2, pl. 3, fig. 1.—Giesbrecht, 1882a, pp. 296, 297.—Aurivillius, 1882a, pp. 63–65, pl. 5, figs. 14–16; 1882b, p. 112; 1883, pp. 33–36, 108, pl. 1, figs. 14–16.—Della Valle, 1883, p. 244.—Carus, 1885, p. 343.—Gourret, 1888, p. 1.—Herdmann, 1889, pp. 248, 249.—Koehler, 1890, p. 137.—Thompson, 1889, p. 187; 1893, p. 190, pl. 18, figs. 3, 3a.—T. Scott, 1897, p. 148; 1901, p. 351; 1907, pp. 366–367.—Graeffe, 1902, p. 40.—Hartmeyer, 1911, p. 1735.—Sars, 1921, pp. 59–60, pl. 29.—Schellenberg, 1922, p. 267.—Hérant, 1931, p. 370.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 121, fig. 76.—Lang, 1948, p. 3.—Sewell, 1949, pp. 183, 188, 191.

Botachus fusiformis Buchholz, 1869, pp. 122–125, pl. 7, fig. 5, pl. 8, fig. 5.—Carus, 1885, p. 344.—Gourret, 1888, p. 1.—Gerstaecker, 1870–1871, pp. 776, 777, 804.—Koehler, 1890, p. 137, fig. 9.—Hartmeyer, 1911, p. 1735.—Sewell, 1949, p. 183.

Distribution: Mediterranean to Sweden and Norway; British Isles.

Hosts: *Ascidians*, *Ascidia canina*, *A. intestinalis*, *A. mentula*, *A. plebeia*, *Ciona intestinalis*, *Phallusia mentula*, *P. obliqua*, *P. mamillata*, *P. monacha*, *P. sp.*

Indeterminable Species

Botachus fulvus Hesse

Botachus fulvus Hesse, 1869, p. 298 (type locality, coast of France, in *Ascidia canina*).—Gerstaecker, 1870–1871, pp. 777, 801.

Botachus macroone Hesse

Botachus macroone Hesse, 1869, pp. 297–298 (type locality, coast of France, in *Ascidia canina*).—Gerstaecker, 1870–1871, pp. 777, 801.—Hartmeyer, 1911, p. 1735.

Genus *Goniodelphys* Buchholz

Goniodelphys Buchholz, 1869, pp. 136–137 (type species, by monotypy, *G. trigona* Buchholz, 1869).—Claus, 1875, p. 350.—Giesbrecht, 1882a, p. 325.—Canu, 1891, p. 475.—Wilson, 1932, p. 599.

Goniodelphys trigona Buchholz

Goniodelphys trigonus Buchholz, 1869, pp. 137–144, pl. 9, fig. 7, pl. 10, fig. 7 (*G. trigona*) (type locality, Naples, Italy).—Carus, 1885, p. 344.—Gerstaecker, 1870–1871, pp. 775, 804.—Grebnitskiĭ, 1873–1874, p. 247.—Hartmeyer, 1911, p. 1735.—Schellenberg, 1922, p. 254.—Sewell, 1949, p. 183.

Distribution: Italy,? Black Sea.

Genus *Ustina* Illg

Ustina Illg, 1951, pp. 30–34 (type species, *Ustina clarki* Illg, 1951).

Ustina clarki Illg

Ustina clarki Illg, 1951, pp. 30–34, fig. 1 (type locality, Sagami Bay, Japan, in unidentified ascidian).

Distribution: Japan.
Host: Unidentified ascidian.

Genus *Notopterophoroides* Schellenberg

Notopterophoroides Schellenberg, 1922, pp. 254–255 (type species, by subsequent designation, Lang, 1948, p. 7, *N. armadillo* Schellenberg).—Gurney, 1927, p. 480.—Wilson, 1932, p. 601.—Lang, 1948, p. 7.—Sewell, 1949, pp. 170, 174.—Illg, 1951, p. 34.

Notopterophoroides armadillo Schellenberg

Notopterophoroides armadillo Schellenberg, 1922, pp. 255–256, figs. 33–35 (type localities: southwestern Australia, Pajunga Islands; in *Ascidia latesiphonica* Hartmr., *A. gemmata* Sluit.).—Lang, 1948, p. 7.—Sewell, 1949, p. 174.—Illg, 1951, p. 34.

Distribution: Australia, Pajunga Islands.
Hosts: *Ascidia latesiphonica* Hartmr., *Ascidia gemmata* Sluit.

Notopterophoroides malacodermatus Schellenberg

Notopterophoroides malacodermatus Schellenberg, 1922, pp. 256–257, figs. 36–37 (type locality, Gulf of Suez, in *Ascidia canelata* Cok.).—Gurney, 1927, p. 480.—Lang, 1948, p. 7.—Sewell, 1949, pp. 170, 179.—Illg, 1951, p. 34.

Distribution: Suez.
Host: *Ascidia canelata* Cok.

Genus *Ophioseides* Giard

Ophioseides Giard, 1873, pp. 498–499 (type species, by monotypy, *O. apoda* Giard, p. 498).

Ophioseides apoda Giard

Ophioseides apoda Giard, 1873, pp. 498–499, 514, pl. 19, figs. 2, 3 (type locality, Roscoff, France, in *Astellium perspicuum*).—Chatton, 1909a, p. 19.—Hartmeyer, 1911, p. 1736.—Schellenberg, 1922, p. 261.
Ophios des apoda Giard, 1873, p. 514.

Distribution: Roscoff, France.
Host: *Astellium perspicuum.*

Genus *Ooneides* Chatton and Brément

Ooneides Chatton and Brément, 1915b, pp. 136–137 (type species, by monotypy, *O. amela*, Chatton and Brément, 1915b).—Wilson, 1932, p. 603.

Ooneides amela Chatton and Brément

Ooneides amela Chatton and Brément, 1915b, pp. 137–143, figs. 1–4 (type locality, Banyuls-sur-Mer, France, in *Leptoclinum dentatum* Della Valle).—Harant, 1931, p. 372.—Sewell, 1949, p. 183.

Distribution: Mediterranean coast of France.
Host: *Didemnum dentatum*(=*Leptoclinum dentatum*).

Genus *Dysgenopsyllus* Nicholls

Dysgenopsyllus Nicholls, 1944, pp. 59–60 (type species, by monotypy, *D. reevesbyensis* Nicholls, 1944).

Dysgenopsyllus reevesbyensis Nicholls

Dysgenopsyllus reevesbyensis Nicholls, 1944, pp. 59–60, fig. 27 (type locality, Reevesby Island, South Australia; type in South Australian Museum).—Sewell, 1949, p. 174.

Distribution: South Australia.

Genus *Brementia* Chatton and Brément

Brementia, Chatton and Brément, 1915a, pp. 129–130 (type species, by monotypy, *B. balneolensis* Chatton and Brément, 1915a).—Wilson 1932, p. 601.

Brementia balneolensis Chatton and Brément

Brementia balneolensis Chatton and Brément, 1915a, pp. 130–134, figs. 1, 2 (type locality, Banyuls-sur-Mer, France, in *Leptoclinum commune* Della Valle).—Harant, 1931, p. 370.—Sewell, 1949, p. 183.

Distribution: Mediterranean coast of France.

Host: *Didemnum fulgens* (=*Leptoclinum commune*).

Genus *Scolecimorpha* G. Sars

Ophioseides Chatton, 1909a, p. 12 (type species, by original designation, *O. joubini* Chatton, 1909a).—Schellenberg, 1922, p. 261.

Scolecimorpha G. Sars, 1926, pp. 1, 3 (type species, by monotypy, *S. insignis* G. Sars, 1926).—Henderson, 1931, p. 217 (part).—Wilson, 1932, p. 601.

Remarks: The species of Sars and of Chatton, as readily established by reference to the figures published with each description, are obviously congeneric, if not conspecific. Accordingly they are here united in Sars' genus, since the tangled nomenclatural history of the name *Ophioseides* could not possibly warrant its retention for these forms.

Scolecimorpha joubini (Chatton), new combination

Ophioseides joubini Chatton, 1909a, pp. 14–18, figs. 1–8 (type locality, Banyuls-sur-Mer, France in *Microcosmus sabattieri* Roule); 1909b, pp. 482–484, fig. [1].—Hartmeyer, 1911, p. 1734.—Chatton and Brément, 1915b, p. 134; 1915c, pp. 150–152, figs. 3, 4.—Schellenberg, 1922, pp. 261, 268.—Harant, 1931, p. 372.—Sewell, 1949, p. 183.

Distribution: France, New Zealand.

Hosts: *Microcosmus sulcatus* (=*M. sabattieri*), *Cnemidocarpa cerea* Sluiter, *Pyura trita* Sluiter.

Scolecimorpha insignis G. Sars

Scolecimorpha insignis G. Sars, 1926, pp. 1–12, pls. 1, 2 (type locality, Trondhjem Fjord, Norway, in *Polycarpa pomaria*).—Henderson, 1931, p. 224.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 125, fig. 86.

Distribution: Trondhjem Fjord, Norway.

Host: *Polycarpa pomaria.*

Genera with North American Representatives

Genus *Notodelphys* Allman

Notodelphys Allman, 1847a, p. 2 (type, by monotypy, *N. ascidicola* Allman, 1847 [indeterminable species]).—Dana, 1853, p. 1443.—Leuckart, 1859, p. 247.—Thorell, 1859a, pp. 26–30.— Gerstaecker, 1863, p. 404.—Claus, 1875, p. 350.—Richiardi, 1880, p. 147.—Giesbrecht, 1882a, pp. 325, 326.—Calman, 1909, p. 103.—Smith, 1909, p 66.—G. Sars, 1921, pp. 30–31.—Schellenberg, 1922, pp. 225–227.—Brehm, 1927, p. 490.—Lang, 1948, pp. 4–6.

Notodelphis Carus, 1885, p. 341.

This genus embraces the forms least modified in the direction of endoparasitism. The body is slender and readily mobile. The head is broader than long, with a long rostrum triangular in outline. The metasome is dorsoventrally depressed. The thoracic segment of the first swimming legs is free in most well known species. The segment is markedly narrower than that succeeding. The second thoracic

segment is broader than the third. The brood pouch arises from the fourth segment, and incorporates the segment of the fifth legs. The furca bears terminally four long plumose setae and also a short unornamented seta on each of the outer and inner margins. The usual ranked length relation of the terminal setae is: outermost, innermost, outer of the two medial setae, inner of the two medial setae.

The antennule is strongly developed, somewhat shorter than the head. In the female it is usually 15-segmented. In the North American species coalescence of segments reduces the number to twelve and ten. The 10- and 12-segmented antennae of the male are bilaterally modified into weakly prehensile appendages with elongate terminal segments. The joint is usually between the ninth and tenth segments. The second antenna is basically trimerous; usually there is a high degree of coalescence of the two proximal segments. First segment bears two plumose setae, exceptionally one. The terminal segment bears on the inner side three bent setae, of which the most lateral arises on a sensory prominence. The surface of this segment is ornamented with a row of denticles. On the inner side and behind the terminal hook are inserted five to six setae, three of which are curved terminally and unornamented.

The coxopodite of the mandible is expanded medially as the masticatory lamella, this with characteristically sculptured medial margin. The basipodite usually bears one seta, laterally inserted. The endopodite is bimerous, the basal segment primitively with four marginal setae, the distal segment with ten. The exopodite exhibits varyingly preserved indications of pentamerism, and usually supports five setae. The terminal seta of the expopodite is usually much stouter than the others.

The coxopodite of the maxillule bears two endites. Nine or ten masticatory setae are borne on the first, a single seta on the second. The basipodite has two to three inner setae. The endopodite is somewhat slenderer than, but about as long as, the exopodite. On the endopodite arise five to six setae. The exopodite bears four setae.

The maxilla is characterized by a very stout process in the form of a sickle-hook on the second segment. It is longer than the accompanying setae.

The maxilliped is trimerous, spatulate in outline. The basal segment is, in some instances, divided again by a transverse furrow. The second segment is somewhat slenderer and much shorter than the first and mostly longer than wide. It bears on the inner side a stout seta, somewhat hooklike. The third segment is truncate, triangular and small. From it arises also a strong hook-spine and one to two less stout plumose setae.

The swimming legs are well developed. The rami are trimerous and of approximately equal length. The representative ornamentation

of the four pairs of swimming legs would be approximated in the following generalized formulation, but certain species may depart from it in particulars. In the first legs, the intercoxal plate is well developed and the coxopodite bears a sizable medial seta; the basipodite bears a lateral seta and distal medial stout spine. The first two segments of the exopodite bear each a lateral spine and medial seta. The distal segment bears three lateral spines, a terminal spine and seta, and three medial setae. The two basal segments of the endopodite each bear a medial seta. The terminal segment bears four medial setae, an apical seta, and a lateral seta. In the second and third legs there is added one medial seta on the terminal segment of the exopodite and one medial seta on the second segment of the endopodite. The third legs are like the second. In the fourth legs the condition of the second legs is altered by the removal of one lateral spine from the terminal segment of the exopodite and one medial seta from the terminal segment of the endopodite.

The fifth legs are bimerous. The basal segment is much expanded laterally to afford insertion for a short seta. The terminal segment bears a reduced spine and a seta, or a solitary seta.

The caudal rami are subcylindrical, with highly developed ornamentation of long plumose setae.

The genus *Notodelphys* as here considered retains its classic description with the most minor of emendations. Obvious coalescence of segments in two observable steps in the North American species provides for the characterization of the antennule as varying from 10-segmented to 15-segmented. The armature of the distal segment of the fifth legs varies from one to two setae or a spine and seta. Lack of availability of suitable specimens of the subtly differentiated European species leads me to accept the results of the major workers on the genus—Thorell, Aurivillius, G. Sars, and Schellenberg—and the diagnoses and key presented here are derived directly from their conclusions.

Stock (1951) has made an important correction in the interpretation of the body segmentation. Most authors have stated that the thoracic segment of the first swimming legs is fused with the head. On the contrary, in *N. rufescens*, *N. agilis*, *N. elegans* and in *N. weberi*, Stock finds this to be a free segment. Material he has kindly provided for the U. S. National Museum of *N. rufescens* confirms this and I have further been able to verify the condition in European specimens of *N. allmani*, *N. elegans*, and *N. prasina* in the collections of the Museum.

Notodelphys is a neatly delimited natural group. All the species which have received adequate description show very close affinity. Some species have had to be considered *species inquirendae*, including

the type of the genus. Examination of the recorded occurrence of the group presents some facts of zoogeographic interest and also emphasizes the great hiatus in knowledge of the ascidicolous copepods from the Pacific and Indo-Pacific regions.

The majority of species are known from Europe, the distribution of most ranging from the waters off Scandinavia around into the Mediterranean. No species is known to occur in great abundance on both sides of the Atlantic. There is a West African and a South African species, and a species from Patagonia completes the Atlantic circle. All of these species share particularly consistent anatomical features, and specific differentiation of them is, in the main, on very refined characteristics. Equally closely affiliated are three species known only from the Gulf of Suez. By contrast, there exists a North American complement of two species, very well differentiated from this larger stock. However the American forms are equivalently subtly separated *inter se*, with a remarkable parallelism thus exhibited in specific differentiation in two major subdivisions of the genus.

The North American forms are the only species that exhibit less than fifteen antennular segments and present an armature of the distal segment of the fifth leg reduced to a single seta. They obviously represent a distinctive genetic stock, and speculation on the zoogeographic aspects of the mechanisms of evolutionary differentiation is inviting. The necessity for increased knowledge of the distribution of the ascidicoles is thus here demonstrated. The available record is most fragmentary for such a readily available group of organisms.

Key to the species of *Notodelphys*, based upon females

1*a*. Terminal segment of fifth leg with a single seta 2
1*b*. Terminal segment of fifth leg with a seta and a spine 3
2*a*. Antennule 10-segmented . . . . monoseta (p. 496)
2*b*. Antennule 12-segmented . . . . affinis (p. 503)
3*a*. Contour of last abdominal segment triangular . . . . . . parva (p. 494)
3*b*. Contour of last abdominal segment rectangular 4
4*a*. Furca markedly shorter than last abdominal segment . . prasina (p. 494)
4*b*. Furca as long as or longer than last abdominal segment 5
5*a*. Furca as long as last abdominal segment 6
5*b*. Furca markedly longer than last abdominal segment 7
6*a*. Last abdominal segment shorter than that preceding . squamifera (p. 495)
6*b*. Last abdominal segment longer than that preceding . . dentata (p. 493)
7*a*. Furca twice as long as last abdominal segment 8
7*b*. Furca 1¼ to 1½ times as long as last abdominal segment 9
8*a*. Lateral seta at middle of the furca . . . . agilis (p. 496)
8*b*. Distance of lateral seta from apex of the furca about equal to the width of the furca . . . . ciliata (p. 493)

9*a*. Distance of lateral seta of furca from the nearest terminal seta less than half the length of the furca but greater than the width of the furca . . 10
9*b*. Distance of lateral seta of furca from the nearest terminal seta not greater than the width of the furca 14
10*a*. Outer margin of first segment of first exopodite ornamented with conspicuous spines or hairs 11
10*b*. Outer margin of first segment of first exopodite entire or inconspicuously ornamented 13
11*a*. Ornamentation of outer border of first segment of first exopodite consisting of long hairs . . . . **patagonica** (p. 494)
11*b*. Ornamentation of outer border of first segment of first exopodite consisting of dense denticulation 12
12*a*. Posterolateral corners of cephalic segment much produced . **weberi** (p. 495)
12*b*. Posterolateral corners of cephalic segment not much produced. **allmani** (p. 492)
13*a*. Claw of the second antenna one-half as long as the concave side of the third segment . . . . **rufescens** (p. 495)
13*b*. Claw of second antenna one-third as long as the concave side of the third segment . . . . **caerulea** (p. 493)
14*a*. Third segment of second antenna about one-third as broad as greatest breadth of the second segment . . . . **pachybrachia** (p. 494)
14*b*. Third segment of second antenna one-half as broad as greatest breadth of the second segment 15
15*a*. Greatest width of third segment of second antenna about two-thirds the length of the terminal claw . . . . **tenera** (p. 495)
15*b*. Greatest width of third segment of second antenna about equal to the length of the terminal claw . . . . **elegans** (p. 493)

Species not known from North America

Notodelphys allmani Thorell

Notodelphys ascidicola Allman, 1847, pp. 2–6, pl. 1, pl. 2, figs. 15–22 (part).
Notodelphys allmanni Thorell, 1859a, pp. 31–35, pl. 1, fig. 1, pl. 2, fig. 1 (type locality, Sweden, in *Ascidia canina* Müller, *A. mentula*); 1859b, pp. 338, 342, 343.—Claus, 1880, p. 553.—Aurivillius, 1882a, pp. 58–59; 1882b, pp. 81–82, 111; 1883, pp. 28–29, 77–78, 107.—T. Scott, 1888, p. 238.—Koehler, 1890, p. 138.—Canu, 1891, p. 472.—Lang. 1948, p. 2; 1951, fig. 5, pl. 1, fig. 1.
Notodelphys allmani Thorell, 1860, pp. 117, 121, 123.—Gerstaecker, 1870–1871, pp. 777, 801, pl. 11, figs. 1–11.—Grebnitskiĭ, 1873–1874, pp. 218, 242–245.—Möbius, 1875, p. 275.—Brady, 1878, pp. 126–129, pl. 25, figs. 1–10.—Kerschner, 1879, pp. 182–183.—Richiardi, 1880, p. 147.—Herdman, 1889, p. 248.—Canu, 1892, pp. 81–83, 188, pl. 13, figs. 1–6.—Thompson, 1889, p. 185; 1893, p. 189, pl. 17, fig. 7.—T. Scott, 1897, p. 148; 1900, p. 386; 1901, p. 351; 1906, p. 362; 1907, pp. 361–362.—Graeffe, 1902, p. 39.—Norman, 1905, p. 36.—Norman and Scott, 1906, p. 201—Hartmeyer, 1911, p. 1735.—G. Sars, 1921, pp. 31–33, pls. 15–16.—Schellenberg, 1922, pp. 227, 262.—Harant, 1931, p. 371.—Marine Biological Association, 1931, p. 172.—Gurney, 1933, p. 304.—Leigh-Sharpe, 1935, p. 48.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 117, fig. 66.—Sewell, 1949, pp. 182, 184, 188, 190.—Stock, 1950, p. 42; 1951, p. 3.

Notodelphys mediterranea Buchholz, 1869, pp. 111–114, pl. 5, fig. 1, pl. 6, fig. 1 (type locality, Naples, Italy).—Gerstaecker, 1870–1871, pp. 775, 804.—Kerschner, 1879, p. 184.
Notodelphys mediterraneus Hartmeyer, 1911, p. 1735.
Notodelphis allmani, Carus, 1885, p. 341.—Gourret, 1888, p. 1.

DISTRIBUTION: Mediterranean to Norway and Sweden; Black Sea; British Isles.

HOSTS: *Ascidia affinis*, *A. canina*, *A. mammillata*, *A. mentula*, *A. sydneiensis* Stps., *A. virginea*, *A. venosa*, *Ascidiella aspersa* (Müller), *A. opalina*, *Ciona canina*, *C. intestinalis*, *C. papillosa*, *Phallusia cristata*, *P. conchilega*, *P. mammillata*, *P. fumigata* Grube, *P. intestinalis*, *P. obliqua*, *P. virginea*, *Phallusia* sp., large ascidians.

Notodelphys caerulea Thorell

Notodelphys caerulea Thorell, 1859a, pp. 37–39, pl. 3, pl. 4, fig. 4 (type locality, Sweden, in *Ascidia venosa* Müller); 1859b, pp. 338–339, 343; 1860, pp. 118, 123.—Norman, 1869, p. 299; 1905, p. 36.—Aurivillius, 1883, pp. 30, 79–80, 107, pl. 1, fig. 17.—Hartmeyer, 1911, p. 1735.—G. Sars, 1921, pp. 34–35, pl. 17, fig. 2.—Shellenberg, 1922, p. 227.—Lang, 1948, p. 2.—Stock, 1951, p. 3.
Notodelphys coerulea Gerstaecker, 1870–1871, pp. 775, 801.—Aurivillius, 1882a, p. 60; 1882b, pp. 83–84, 111.—Norman and Brady, 1909, p. 400.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 117.—Sewell, 1949, p. 188.
Notodelphys cerulaea Brady, 1878, p. 130, pl. 27, figs. 10–13.

DISTRIBUTION: Atlantic coast of Europe to Norway and Sweden; British Isles.

HOSTS: *Ascidia parallelogramma*, *A. venosa* Müller, *A. virginea*, *Corella parallelogramma*, *Phallusia virginea*.

Notodelphys ciliata Schellenberg

Notodelphys ciliata Schellenberg, 1922, pp. 228–229, fig. 2 (type locality, Gulf of Suez, in *Phallusia nigra* Sow.).—Gurney, 1927, p. 480.—Sewell, 1949, pp. 169, 179.

DISTRIBUTION: Gulf of Suez.

HOST: *Phallusia nigra* Sow.

Notodelphys dentata Schellenberg

Notodelphys dentata Schellenberg, 1921, pp. 3–6, figs. 1–4 (type locality, Norway, in *Rhopalaea nordgaardi* Hartmr.).—Schellenberg, 1922, p. 227.

DISTRIBUTION: Norway.

HOST: *Rhopalaea nordgaardi* Hartmr.

Notodelphys elegans Thorell

Notodelphys elegans Thorell, 1859a, pp. 39–40, pl. 4, fig. 5 (type locality, Sweden, in *Ascidia intestinalis* (Müller)); 1859b, pp. 339, 343; 1860, pp. 118, 123.—Gerstaecker, 1870–1871, pp. 776, 801.—Möbius, 1873, p. 116; 1875, pp. 274–275.—Brady, 1878, p. 126.—? Kerschner, 1879, p. 184.—Richiardi, 1880,

p. 147.—Aurivillius, 1882b, pp. 78–81, 111, pl. 15, figs. 14–18, pl. 16, figs. 1–3; 1883, pp. 74–77, 107, pl. 6, figs. 14–18, pl. 7, figs. 1–3.—Canu, 1891, p. 472; 1892, p. 189.—Hartmeyer, 1911, p. 1735.—G. Sars, 1921, p. 37, pl. 18, fig. 2.—Schellenberg, 1922, p. 227.—Harant, 1931, p. 371.—Klie, 1933, p. 16.—Pesta, 1934, pp. 10–11, fig. 7.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, pp. 117–118.—Lang, 1948, p. 2.—Sewell, 1949, pp. 182, 188, 190.—Stock, 1951, p. 1.

Notodelphis elegans Carus, 1885, p. 341.—Gourret, 1888, p. 1.

DISTRIBUTION: Mediterranean to Norway and Sweden; British Isles.

HOSTS: *Ascidia canina*, *Ciona intestinalis*.

Notodelphys pachybrachia Schellenberg

Notodelphys pachybrachia Schellenberg, 1922, pp. 231, 262, figs. 5–6 (type locality, Gulf of Suez, in *Ascidia canelata*).—Gurney, 1927, p. 480.—Sewell, 1949, pp. 169, 179.

DISTRIBUTION: Gulf of Suez.

HOST: *Ascidia canelata* (Sav. Ok.).

Notodelphys parva Schellenberg

Notodelphys parva Schellenberg, 1922, pp. 231–232, 263, figs. 7, 8 (type locality, Gulf of Suez, in *Pyura momus*, *Polycarpa ehrenbergi*).—Gurney, 1927, p. 480.—Sewell, 1949, pp. 169, 179.

DISTRIBUTION: Gulf of Suez.

HOSTS: *Pyura momus* Sow., *Polycarpa ehrenbergi* Hartmr.

Notodelphys patagonica Schellenberg

Notodelphys patagonica Schellenberg, 1922, pp. 228, 263, fig. 1 (type locality, Patagonia, in *Ascidia tenera*).—Lang, 1948, pp. 4–5.

DISTRIBUTION: Patagonia.

HOST: *Ascidia tenera* Herdm.

Notodelphys prasina Thorell

Notodelphys prasina Thorell, 1859a, pp. 41–42, pl. 5, fig. 7; 1859b, p. 339; 1860, pp. 118, 123.—Norman, 1869, p. 299.—Gerstaecker, 1870–1871, pp. 776–777, 801.—Brady, 1878, pp. 131–132, pl. 30, figs. 11–15.—Kerschner, 1879, pp. 183–184, pl. 6, fig. 16.—Giesbrecht, 1882a, pp. 295–296.—Aurivillius, 1882b, pp. 84–87, 111, pl. 16, figs. 4–7; 1883, pp. 32–33, 80–91, 107, pl. 7, figs. 4–7.—T. Scott, 1897, p. 148; 1900, p. 386; 1901, p. 351.—Graeffe, 1902, p. 39.—Norman, 1905, p. 36.—Norman and Scott, 1906, p. 202.—T. Scott, 1907, p. 362—Hartmeyer, 1911, p. 1735.—G. Sars, 1921, pp. 37–38, pl. 18, fig. 3.—Schellenberg, 1922, pp. 227, 263.—Harant, 1931, p. 371.—Marine Biological Association, 1931, p. 173.—Leigh-Sharpe, 1935, p. 48.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 118, fig. 67.—Lang, 1948, p. 2.—Sewell, 1949, pp. 182, 188, 190.

Notodelphys pusilla Buchholz, 1869, pp. 115–116, pl. 6, fig. 2.—Gerstaecker, 1870–1871, pp. 775, 804.—Hartmeyer, 1911, p. 1735.

Notodelphis prasina Carus, 1885, p. 341.—Gourret, 1888, p. 1.

Distribution: Mediterranean to Norway and Sweden; British Isles.

Hosts: *Ascidia canina*, *A. mentula* Müller, *Ascidiella aspersa*, *Ciona intestinalis*, *Phallusia mammilata* (Cuvier), *P. mentula*, *Phallusia* sp.

Notodelphys rufescens Thorell

Notodelphys rufescens Thorell, 1859a, pp. 35–36, pl. 2, fig. 2; 1859b, pp. 338, 343; 1860, pp. 117–118, 123.—Gerstaecker, 1870–1871, pp. 775, 801.—Kerschner, 1879, p. 183, pl. 1, figs. 1–3, pl. 2, figs. 7, 8, 10, pl. 3, fig. 4, pl. 6, figs. 13–15.—Aurivillius, 1882a, pp. 56–60; 1882b, pp. 82–83, pl. 16, fig. 8; 1883, pp. 29–30, 78–79, 107, pl. 7, fig. 8.—Graeffe, 1902, p. 39.—Hartmeyer, 1911, p. 1735.—G. Sars, 1921, pp. 33–34, pl. 17, fig. 1.—Schellenberg, 1922, pp. 227, 263.—Hansen, 1923, p. 22.—Stephensen, 1929, p. 6,—Harant, 1931, p. 372.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 117.—Stephensen, 1940, p. 20.—Lang, 1948, p. 2.—Sewell, 1949, pp. 182, 190, 193.—Stock, 1951, pp. 1–3, figs. 1–7.

Notodelphis rufescens Carus, 1885, p. 341.—Gourret, 1888, p. 1.

Distribution: Mediterranean to Norway and Sweden; Faroes.

Hosts: *Ascidia aspersa* Müller var.?, *A. conchilega*, *A. cristata* Heller, *A. obliqua*, *Ascidiella aspersa*, *A. scabra*, *Phallusia conchilega*, *P. obliqua*.

Notodelphys squamifera Schellenberg

Notodelphys squamifera Schellenberg, 1922, p. 230, figs. 3, 4 (type locality, West Africa, in *Microcosmus senegalensis* Mchlsn.)

Distribution: West Africa.

Hosts: *Microcosmus senegalensis* Mchlsn.

Notodelphys tenera Thorell

Notodelphys tenera Thorell, 1859a, pp. 36–37, pl. 3, fig. 3; 1859b, pp. 338, 343; 1860, pp. 118, 123.—Gerstaecker, 1870–1871, pp. 777, 801.—Richiardi, 1880, p. 147.—Aurivillius, 1882b, pp. 70–78, 111, pl. 15, figs. 4–13; 1883, pp. 66–74, 107, pl. 6, figs. 4–13.—Hartmeyer, 1911, p. 1735.—G. Sars, 1921, p. 36, pl. 18, fig. 1.—Schellenberg, 1922, pp. 227, 263.—Harant, 1931, p. 372.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 117.—Lang, 1948, p. 2.—Sewell, 1949, p. 182.—Lang, 1951, fig. 6.

Notodelphis tenera, Carus, 1885, p. 341.—Gourret, 1888, p. 1.

Distribution: Mediterranean to Norway and Sweden.

Hosts: *Ascidia canina* Müller, *A. mammillata* Cuvier, *A. mentula*, *A. obliqua*, *Ciona intestinalis*, *Phallusia mentula*, *P. obliqua*.

Notodelphys weberi Stock

Notodelphys weberi Stock, 1950, pp. 37–42, figs. 1–3 (type locality, Knysna, South Africa, in *Ascidia canaliculata* Heller).

Distribution: South Africa.

Host: *Ascidia canaliculata* Heller.

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North American Species

Notodelphys agilis Thorell

Notodelphys agilis Thorell, 1859a, pp. 40–41, pl. 4, pl. 5, figs. 5a–6 (type locality, Sweden, in *Ascidia parallelogramma, A. mentula, A. canina, A. aspersa*); 1859b, pp. 338, 343; 1860, pp. 117, 123.—Gerstaecker, 1870–1871, pp. 775–777, 801.—Möbius, 1875, p. 274.—Brady, 1878, pp. 130–131, pl. 26, figs. 1–10.—Claus, 1880, p. 553.—Aurivillius, 1882a, pp. 60–62; 1882b, p. 111; 1883, pp. 30–32, 107; 1885a, p. 230; 1885b, p. 282; 1886, p. 44.—Giesbrecht, 1882b, p. 88.—Dalla Torre, 1889, p. 86.—Canu, 1891, p. 472; 1892, pp. 78–81, pl. 12, figs. 1–8.—Timm, 1894, p. 396.—T. Scott, 1888, p. 238; 1897, p. 148; 1901, p. 351; 1906, p. 362; 1907, p. 362.—Norman, 1905, p. 36.—Norman and Brady, 1909, p. 400.—Hartmeyer, 1911, pp. 1734–1735.—Wilson, 1920, p. 15.—G. Sars, 1921, pp. 35–36, pl. 17, fig. 3.—Schellenberg, 1922, pp. 227, 262.—Harant, 1931, p. 371.— Wilson, 1932, p. 387, fig. 238.—Gray, 1933, p. 519.—Gurney, 1933, p. 303.—Pesta, 1934, p. 10, fig. 6.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 117.—Lang, 1946, p. 9, fig. 3; Lang, 1948, pp. 2, 20–22, fig. 16.—Sewell, 1949, pp. 157, 158, 184, 188, 190.—Stock, 1951, p. 1.

Notodelphis agilis Herdman, 1891, p. 207.

Distribution: Mediterranean and Atlantic coasts of Europe, British Isles; ? North America, Atlantic coast.

Hosts: *Ascidia parallelogramma, A. mentula, A. canina, A. aspersa, A. virginea, A sordida, A. obliqua, Ascidiella aspersa, Ascidiella opalina, Ascidiella patula, Caesira socialis, Ciona intestinalis, Corella parallelogramma, Molgula ampulloides* (*Bened.*), *M. holtiana* Herdman, *M. socialis* Alder, *Phallusia mentula, P. obliqua, Polycarpa comata* (Ald.), *Polycarpa gracilis*.

Remarks: Published records assign this species to the North American fauna. Some of the reported occurrences have been checked and the specimens upon which they were based have been found to be representatives of other species, hence no authoritative material was available for the present study. The diagnostic features of the species were illustrated by G. Sars (1921, pl. 17, fig. 3).

Notodelphys monoseta Pearse

Figure 1

Notodelphys monoseta Pearse, 1947, p. 7, figs. 36–40 (type locality, Beaufort, N. C., in *Ascidia interrupta* Heller).

Specimens examined:

North Carolina

From *A. interrupta:*

Beaufort, dredged, May 25, 1946, A. S. Pearse, holotypic female, allotypic male, 6 females, 3 males.

Description: Female (fig. 1,*a–o*): General features: The depressed body (fig. 1,*a*) is 10-segmented. The metasome consists of a cephalic

segment, three free segments bearing the first three pairs of swimming legs, and a much expanded incubatory segment which bears the fourth and fifth legs. The urosomal portion of the body consists of five segments. The first of these bears the oviducal apertures and it is the shortest of the five. The succeeding four are subequal in length. The last bears the caudal rami which are about one and a third times as long as the fifth segment.

The first free thoracic segment lacks epimera. The head complex and free segments 2 and 3 are much expanded laterally and somewhat ventrally into well-developed epimera.

The rostrum (fig. 1,*b*) is conspicuous, extending between the bases of the antennules as a posteriorly arching tapered beak. The apex is obtuse and the rostrum is considerably flattened.

Head appendages: The antennule (fig. 1,*c*) is composed of 10 segments. All are well sclerotized although some traces are apparent of a fundamentally greater number of segments. The basal segments are much enlarged in diameter and the appendage tapers by some telescopic intervals and some gradual transitions to an extremely small subquadrate apical segment. The sixth segment is the longest and bears indentations of the integument indicating coalescence of probably three primary subdivisions. The basal diameter of the segment is about two thirds the length and roughly three-fifths the diameter of the proximal segment of the appendage. Details of setation are not readily determinable from the available specimens but there is indication of possession of markedly distinctive features.

The segments of the trimerous antenna (fig. 1,*d*) are all relatively short and stout. The two proximal segments are closely coalesced and at the point of union on the inner side of the right-angled flexure which the antenna usually presents there are inserted on the proximal segment two well-developed setae. The articulation of the two basal segments is diagonal so that the second segment has an inner margin (relative to the flexure) of about half the diameter of the segment. The outer margin slightly exceeds the diameter of the segment. A short distance subterminally on the outer margin there is inserted a reduced seta. The second segment is widest. The proximal segment tapers sharply toward the base.

The length of the distal segment (fig. 1,*e*) is about two times its greatest width. The distal margin is widely truncate. The outer third of this margin participates in the complicated articulation of a terminal, stout, tapered, curved spine, the length of which somewhat exceeds the greatest diameter of the segment. Inserted in the region of articulation of the spine are three curved setae, graduated in length from the longest which about equals the spine. There are two additional short setae inserted on the distal margin of the segment.

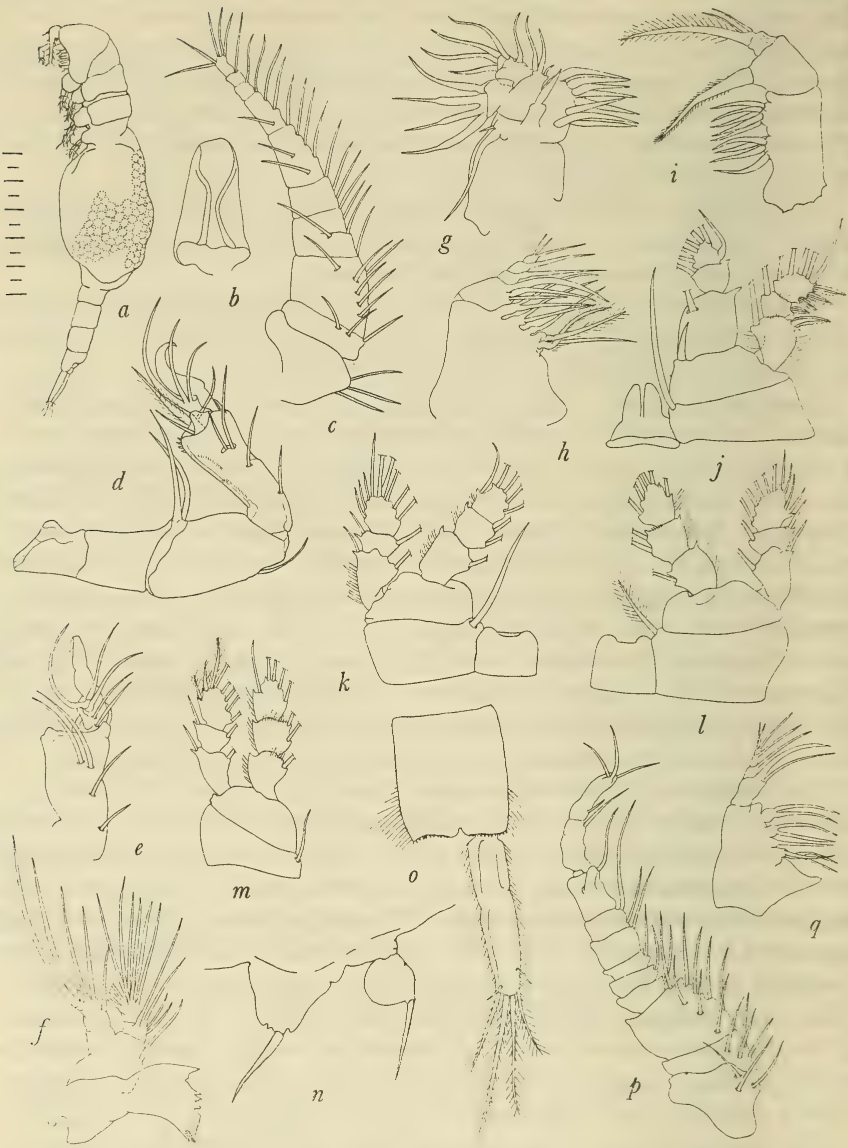

FIGURE 1.—*Notodelphys monoseta* Pearse. *a–o*, Female: *a*, habit, lateral view; *b*, rostrum; *c*, antennule; *d*, antenna; *e*, terminal segment of antenna; *f*, mandible; *g*, maxillule; *h*, maxilla; *i*, maxilliped; *j*, first leg; *k*, second leg; *l*, third leg; *m*, fourth leg; *n*, fifth leg; *o*, caudal ramus. *p*, *q*, Male: *p*, antennule; *q*, maxilla. The scale, referring to *a*, represents 1.0 mm.

About a third of the length of the segment proximal from the apex there are set on the surface a pair of well-developed setae. Slightly posterior to these and closer to the outer margin there is a single seta. Another single seta is inserted on the lateral margin distal about one-third the length of the segment from its articulation. There are two parallel rows of spinules curving over the surface of the segment near its inner margin.

The incisor process of the mandible (fig. 1,*f*) is a medial prolongation of the coxopodite. It is a flat blade, expanded to an elongate serrate margin. At the top distal corner the blade is produced as a stout curved tooth. Below a considerable emargination the masticatory saw consists of three equispaced teeth of similar development; a long, finely serrate bladelike region; and, at the bottom, two slender, seta-like projections.

The basipodite is subquadrate in outline and bears on the medial margin a single well-developed seta. The endopodite consists of two subequal segments. The proximal segment bears a row of four graduated setae, their bases set in a curve around the distal medial margin. The nine setae of the terminal segment are arranged in two groups. Three setae originate on a lateral distal prolongation of the segment. The remainder of the distal margin is occupied by the close-set bases of the six remaining graduated setae.

The exopodite is relatively large, obscurely tetramerous. Four of the five setae are subequal; the apical seta is much enlarged, its length and thickness about double those of the next larger. The insertions of the three proximal setae seem to indicate distal limits of segments. The distal seta is accompanied by a seta placed just subapically and apparently sharing insertion on the terminal segment.

The maxillule (fig. 1,*g*) is characterized by massiveness of the basal portion. The protopodite seems to be 2-segmented. The proximal segment is extended distally as the prominent major endite, this accompanied by a second minor endite, which is represented by a slender setiform structure borne on a prominence. The armature of the proximal endite consists of nine diversified setae, close-set to form a medial masticatory fringe.

An epipodite is represented by a small prominence lateral on the basal segment, from which extends a long stout seta and a reduced auxiliary setule. The orientation of the second segment, which is probably the basipodite, is shifted so that the rami are directed almost laterally and the usually lateral setae are distal. There are two of these, subequal in dimensions. The endopodite is a small, somewhat conical plate ornamented with five setae. One of these is inserted at about the midpoint of the medial margin. The remainder are apical.

The exopodite is a truncated curved structure. The medial margin is strongly convex, the lateral concave. The four large subequal setae are accommodated along the distal margin.

The roughly triangular maxilla (fig. 1,*h*) is pentamerous. The basal segment much exceeds the remainder and bears four variously developed endites. The proximal endite bears three setae apically placed. The second endite is represented by a slight eminence bearing a single seta. The third endite bears two setae. The fourth endite is the largest. It bears two apical setae and a subterminally inserted accessory setule.

The second segment is longer than wide and is produced medially and distally as a very stout, heavily sclerotized hooked spine. Inserted on the base of the spine are two unequal setae.

The third and fourth segments bear each a single distal medial seta. The fifth segment bears two terminal setae, one reduced subapical seta, and a vestige of a setule inserted medially near the base.

The trimerous maxilliped (fig. 1,*i*) is a flattened rectilinear appendage with a setiferous inner margin. The basal segment is slightly more than twice as long as wide. Its nine setae are disposed in two groups. Each group has one seta displaced considerably laterally on the anterior surface of the segment. The remaining trio and quartet of setae are inserted, with close-spaced bases, on the medial margin.

The nearly quadrate second segment is just slightly narrower than the first. Its ornamentation is a single very stout, long, curved seta inserted on the distal medial corner.

The third segment is reduced to little more than a small process articulated on the distal lateral corner of the second segment. It is produced apically as a long stout seta which is disposed in a medially directed curve. Inserted on the base of this principal seta is a minute accessory setule.

Swimming legs: The first legs (fig. 1,*j*) consist of bimerous protopodites and trimerous rami. The coxopodites are yoked together by a heavily sclerotized intercoxal plate. Inserted on the distal medial corner of each coxa is a well-developed seta, thick at the base and finely tapering apically, extending to the tip of the endopodite. The basipodite is characterized by an exceedingly short lateral margin. Inserted near the margin is a reduced lateral seta. The medial distal corner of the basis supports a rather weakly developed spine which reaches to about the midpoint of the basal segment of the endopodite. Each of the two basal segments of the exopodite bears a lateral spine and a medial seta. The terminal segment bears three marginal lateral spines, two apical setae, and three medial marginal setae. The lateral terminal seta is heavily sclerotized at the base, suggesting that it replaces the spine usually inserted at this

side. The two most distal spines and that of the basal segment are rather elongate and taper to slender tips invested in finely serrate marginal flanges. A prominent spinous prominence projects from each of the two basal segments just proximal to the insertion of its spine. The spines of the terminal segment have accompanying prominences of markedly feebler development.

The basal segment of the endopodite much exceeds the combined mass of the distal segments. It bears one seta, inserted somewhat proximal to the distal medial corner. The second segment bears one medial seta. The distal lateral corner of the segment is produced as a short, stout, slightly curved, spinous projection. The terminal segment is nearly right triangular in outline due to the greatly reduced extent of the medial margin and the diagonally directed distal boundary. Across the distal margin is set a row of five close-spaced setae. The proximal four of these are subequal, the apical seta is reduced. At the proximal corner of the medial margin originates a sixth short slight seta.

The second leg (fig. 1,*k*) consists of a bimerous protopodite and trimerous rami. The coxopodites are yoked by a well-developed subquadrate intercoxal plate. Each coxa bears at the medial distal corner a fairly robust seta which extends to about the base of the distal segment of the endopodite. There is a reduced seta inserted near the lateral margin of the basipodite. The two basal segments of the exopodite are markedly contracted proximally and expanded distally. Each bears a lateral spine and a medial seta. Each spine is accompanied by a proximally placed stout spinous projection of the margin of the segment. The terminal podomere is somewhat less constricted basally. Its widest point is at the proximal fourth whence it tapers somewhat to the apex. There are three lateral marginal spines, two apical setae, and four medial setae. All the spines are so slender as to approach setiform dimensions, except for the reduced length.

The segments of the endopodite are somewhat constricted basally. The proximal segment bears one medial seta. The second segment bears two medial setae. The ornamentation of the distal segment consists of three medial setae, two apical setae, and one seta set in an emargination at about the midpoint of the lateral margin. The insertions of the lateral apical seta and the lateral marginal seta and the distal lateral corners of the two proximal segments are ornamented by stout spinous projections of the integument.

The coxopodites of the third legs (fig. 1,*l*) are joined by a well-developed intercoxal plate. At the distal medial corner of each coxa there is inserted a well-developed seta extending to about the middle of the second segment of the endopodite. There is a somewhat

reduced seta inserted near the lateral margin of the basipodite. The two proximal segments of the trimerous exopodite each bear a lateral spine and a medial seta. The ornamentation of the terminal segment consists of three lateral spines, a weak apical spine much modified to present a markedly setiform aspect, except for reduction in length, an apical seta, and four setae inserted on the medial margin.

The armature of three segments of the endopodite consists of one medial seta on the basal segment, two medial setae on the second segment, three medial setae, two apical setae, and one lateral seta on the distal segment.

The fourth leg (fig. 1,*m*) consists of a bimerous protopodite and trimerous rami. The plate yoking the coxopodites is shorter than wide. At the distal medial corner of the coxa is inserted a seta which does not quite reach the distal corner of the somewhat produced medial margin of the basipodite. A seta is inserted near the lateral margin of the basipodite.

The two proximal segments of the exopodite bear each a medial seta and a lateral spine. These spines and those of the distal segment are much reduced, pronouncedly modified in the direction of setiform structure. They are of about the diameter of the most basal seta of the ramus and thus slenderer than the remaining setae. They taper uniformly to extremely fine points, and actually offer no differentiating features from setae on a structural basis. The terminology is here preserved because they occupy the usual points of insertion of spines. The distal segment bears two short lateral spines, a somewhat longer apical spine and an apical seta, and four medial marginal setae.

The proximal segment of the endopodite bears one medial seta. The second segment bears two medial setae. The distal segment bears two medial marginal setae, two apical setae, and one seta on the lateral margin.

Vestigial legs and caudal rami: The bimerous fifth legs (fig. 1,*n*) are much reduced. The basal segment is produced distally at the lateral corner to form a considerable prominence on which is inserted a seta. This setiferous prominence is a stout truncated cone produced almost directly posteriorly. The second segment is small, exceeded considerably by the projection of the basal segment. There is a single short seta borne at the medial distal corner of the terminal segment. The remainder of the distal margin and the lateral margin of this segment form an uninterrupted extent which approaches a semicircular outline.

The caudal rami (fig. 1,*o*) are about five times as long as their greatest width, which is just distal to the constricted base. From the point of greatest width the rami taper slightly to the somewhat

rounded truncate apex. The integument seems to be fairly heavily sclerotized and there is a characteristic ridge of the integument running near to and paralleling the medial margin. The margins of the rami are ciliated. Four setae form a fanlike array across the distal margin of the ramus. The central setae of the quartet are the longest. They are subequal and the length is about seven-eighths that of the ramus. The medialmost and outermost setae are similar, about three-fifths the length of the long setae. On the dorsal surface of the ramus there are inserted two reduced setae. One is just subapical and near the medial margin. The other is on the lateral margin and displaced from the end of the ramus by a distance about equal to the terminal width.

Male (fig. 1,*p–q*): A typical cyclopoid male, 10-segmented with geniculate antennule (fig. 1,*p*). The appendages conform well to those of the female, except that the maxilla (fig. 1,*q*) is somewhat simplified and the swimming legs are more spinose. The usual sixth legs, consisting of setiferous flaps placed over the seminal vesicles, are present.

***Notodelphys affinis*, new species**

FIGURE 2

Doropygopsis longicauda Wilson, 1935a, p. 779, (part).

TYPES: Holotypic female, USNM 92816 (type locality, off Iceberg Point, Lopez Island, Washington, from *Ascidia paratropa* (Huntsman)); allotypic male, USNM 92817, same locality and host; paratypes listed below.

SPECIMENS EXAMINED:

WASHINGTON

From *A. paratropa:*

- Lopez Island, off Iceberg Point, dredged, 30 meters, July 3, 1939, holotypic female, allotypic male.
- Lopez Island, off Upright Head, dredged, 15 fms., July 27, 1949, R. L. Fernald, 22 females.
- Off Lopez Island, opposite lower end Fisherman's Bay, dredged, July 13, 1950, 1 female.
- East of Upright Channel, dredged, 25–35 fms., June 23, 1950, 2 females.
- Upright Channel, dredged, July 25, 1950, R. L. Fernald, 35 specimens.
- Near Friday Harbor, dredged, July, 1950, 8 females.
- Puget Sound, dredged, Aug. 18, 1949, R. L. Fernald, 10 females.

From *Ascidia callosa* Stimpson:

- East of Upright Channel, dredged, 25–35 fms., June 23, 1950, 30 females.
- Upright Channel, dredged, July 19, 1950, 3 females.
- Off Dinner Island, dredged, 30 fms., Aug. 10, 1949, R. L. Fernald, 5 specimens.
- Brown's Island, San Juan Island, intertidal, July 14, 1950, 5 females.
- Turn Point, San Juan Island, intertidal, July 16, 1950, 17 specimens.

From *Corella willmeriana* Herdman:

Entrance to West Sound, Orcas Island, dredged, 30 fms., Aug. 10, 1949, R. L. Fernald, 55 females, 2 males, 3 juveniles.

East of Upright Head, Lopez Island, dredged, June 23, 1950, 25 specimens.

President Channel, San Juan Islands, dredged, 105 fms., July 8, 1950, 6 specimens.

California

From *Phallusia vermiformis* Ritter:

Off Santa Cruz Island, dredged, Feb. 6, 1889, U. S. Fish Comm. Steamer *Albatross*, 1 female.

Description: Female (fig. 2,*a–m*): General features: The body (fig. 2,*a*) is neatly delimited into metasome and urosome. The anterior portion consists of the head, the three free thoracic somites corresponding to the first to third swimming legs, and the expanded brood sack which is a development of the fused somites of the fourth and fifth legs. The articulation of the metasome and urosome falls between the sixth thoracic segment, which bears the fifth legs, and the succeeding seventh thoracic segment.

The urosome (fig. 2,*b*) is slender, subcylindrical, with only a slight taper posteriorly. There are five distinctly demarcated segments. The first is the shortest, and by the presence of the oviducal apertures and the structures connected with the seminal receptacles, it is established as the last thoracic somite. The succeeding four abdominal somites show no significant differentiation in size or proportions.

The front margin of the head is prolonged ventrally as the stout blunt rostrum. This structure is short, about 1½ times as long as its basal width, and tapers uniformly to the rounded apex, which is about half as wide as the base.

Head appendages: The 12-segmented antennule (fig. 2,*c*) is stocky, not reaching to the posterior margin of the head. The taper of the appendage is gradual so that each segment is but slightly narrower than that next proximal. The posture of the antennule is a nearly right-angled flexure which results from the diagonal articulations of the second segment with the first and third. The effect of this arrangement is an approximately triangular outline of the second segment with its outer margin several times longer than the very short inner margin. The other articulations of the antennular segments are transverse to the main axis. The first two segments are much shorter than wide and roughly wedge-shaped. The length of the third segment approaches the sum of the lengths of segments 1 and 2. The fourth segment is roughly rectangular in outline, the length three-fourths the width. The fifth segment is smaller than the preceding, of similar outline. The sixth segment, elongate and markedly tapered, preserves in the sculpturing of the integument evidence of its formation by coalescence of three of the segments usually

occurring at this position in *Notodelphys* species. The succeeding six segments are subequal, short and quadrangular, and taper only very slightly to the apex. The ornamentation of the antennule is an array of numerous setae, mostly plumose, the arrangement of which does not offer any distinctively specific feature.

The antenna (fig. 2,*d*) is distinctive for the unusually developed coalescence of the basic first and second segments of the usual three, so that functionally the appendage is bimerous. The right-angled flexure provides a reference of orientation to the appendage. Indication of the fundamental segmentation is preserved in the diagonal, groove across the segment and the insertion of two long, subequal plumose setae on the inner margin at the point of intersection of the groove. Subterminally on the outer margin is inserted a much shorter, slighter, reduced seta. The distal segment is smaller in extent than the basal unit, both narrower and shorter. Inserted near the lateral margin at intervals equal to about a fourth of the length of that margin are a proximal reduced seta, a second seta at about the midpoint, and a trio of setae at the distal fourth. Forming a complicated insertion on the distal margin of the segment is a stout, tapered, much-curved hook accompanied by four variously developed setae. Fairly heavy spinules form curving lines over the surface of the segment near the inner margin.

The mandible consists of the bimerous protopodite and the usual rami. The medial expansion of the coxopodite (fig. 2*e*) forms a lamella which, along the masticatory margin, is differentiated as four widely-spaced toothlike projections, a short, finely serrate saw-edge, and two small setiform processes. The basipodite is a long segment (fig. 2,*f*) and bears a well-developed seta inserted at the distal third of the inner margin. The proximal segment of the biramous endopodite bears four setae arranged in a row around the distal medial margin. Occupying the distal margin of the second segment are nine setae disposed in two groups of three and six.

The segmentation of the exopodite is suppressed so that the condition is apparently bimerous. One seta is borne on the basal portion, four distally. The setae are graduated in length distally and the terminal seta is the longest with the basal third much expanded as well.

The maxillule (fig. 2,*g*) consists of an obscurely bimerous protopodite and the two monomerous rami. Laterally on the basal portion of the protopodite there is a vestigial epipodite represented by a long stout seta accompanied by a minute accessory setule. Two medial expansions of the basal part of the protopodite represent endites. The more proximal endite is a flaring expansion bearing a row of ten setae disposed along the medial margin. The second endite is repre-

sented by a reduced prominence from which extends a long tapering setiform structure. The endopodite bears five setae, one inserted just subapically on each of the medial and lateral margins and three borne along the distal extremity. The exopodite is widely truncate distally and four large setae are arranged along this margin in a loosely set row.

The major bulk of the pentamerous maxilla (fig. 2,*h*) consists of the basal section. This bears four setiferous medial projections which represent endites. The most proximal projection bears three subequal setae. The ornamentation of the second endite is reduced to a solitary seta. The third endite bears two nearly equal setae. The fourth endite supports two well-developed, equal setae and a reduced setule which is inserted near the base of the more proximal seta. The second segment is about as wide as long in its main mass but is produced medially as a long, stout, falcate process on which the proximal margin is finely denticulate. Inserted basally on this process is an equally long but more slender seta and a much reduced seta. The third and fourth segments each bear a long slender seta inserted at the distal medial corner. The minute fifth segment bears four setae, three subequal ones forming an apical group, with a fourth, much-reduced, inserted proximally on the segment near the medial margin.

The trimerous maxilliped (fig. 2,*i*) is stout and well developed. The basal segment constitutes about two-thirds of the total mass. Its ornamentation consists of nine setae arranged in two groups. The proximal group consists of three setae arranged in close-set formation at about the midpoint of the medial margin. A fourth seta accompanies this group, its insertion displaced considerably laterally to the surface of the segment. Five setae are similarly arranged as a marginal quartet and solitary superficial seta, the group occupying the margin at a level marking the distal quarter of the segment. The mass of the second segment is slightly less than half that of the first. The outline is roughly trapezoidal. Inserted at about the midpoint of the medial margin is the single stout elongate seta. The armature of this member is distinctive, consisting of profuse ciliation basally and marginal denticulation distally. The terminal segment is minute, reduced to little more than a base for the insertion of the three terminal setae. One of these is long and tapered, with plumose ciliation. The accompanying two setae are reduced to very slight proportions.

Swimming legs: The first swimming legs (fig. 2,*j*) consist of bimerous protopodites and trimerous rami. The coxopodites are yoked by a well-developed intercoxal plate of subtriangular outline. Surface sculpturings of the plate convey a characteristic aspect featured by a

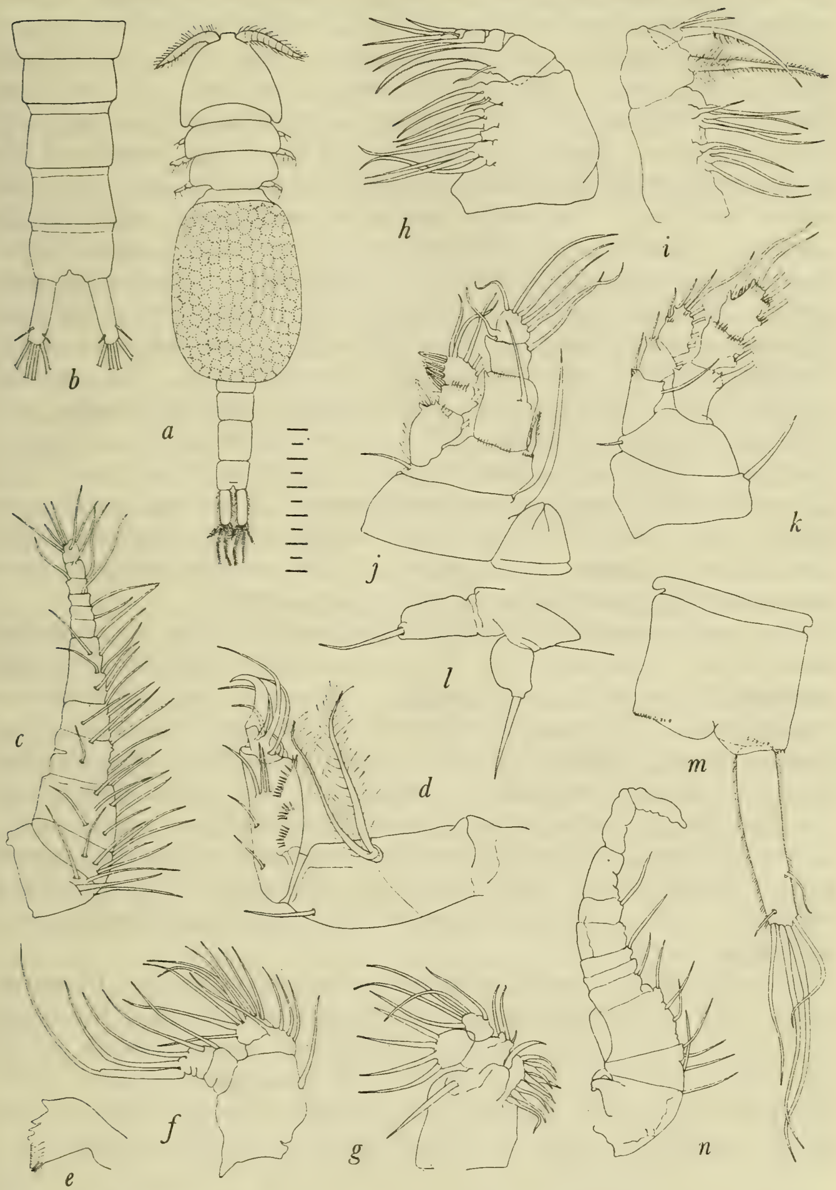

FIGURE 2.—*Notodelphys affinis*, new species. *a–m*, Female: *a*, habit, dorsal view; *b*, urosome; *c*, antennule; *d*, antenna; *e*, masticatory lamella of mandible; *f*, palp of mandible; *g*, maxillule; *h*, maxilla; *i*, maxilliped; *j*, first leg; *k*, fourth leg; *l*, fifth leg; *m*, caudal ramus. *n*, Male: antennule. The scale, referring to *a*, represents 1.0 mm.

bilobed distal margin. Inserted on the distal medial corner of each coxopodite is a robust, long, tapered seta, reaching to the distal margin of the second segment of the endopodite. The outline of the basipodite is distinctive. The lateral margin is reduced to a very short distance. Half the width of the segment is terminated by a diagonally directed border. From the midpoint of the distal margin to the distolateral corner the border is roughly squarely transverse to the axis of the limb. The medial margin is two-fifths the width of the segment. Inserted near the short lateral margin is a slender seta. A stout, tapering spine is set at the medial distal corner of the basipodite. The spine extends to the level of the distal third of the basal segment of the endopodite. Each of the two basal segments of the exopodite bears a lateral spine and a medial seta. The terminal segment bears three marginal lateral spines, two apical setae, and three medial marginal setae. The two most distal spines and that of the basal segment are rather elongate and taper to slender tips. They all possess finely serrate marginal flanges. A spinous prominence projects from each of the two basal segments just proximal to the insertion of its spine. The spines of the terminal segment have accompanying prominences of feebler development.

The basal segment of the endopodite much exceeds the combined mass of the distal segments. It bears one seta, inserted somewhat proximal to the distal medial corner. The second segment bears one medial seta. The distal lateral corner of the segment is produced as a short, stout, slightly curved, spinous projection. The terminal segment is nearly triangular in outline with the medial margin and the diagonally directed distal boundary inclining to a narrow apex. Across the distal and medial margins is set a row of five close-spaced setae. The proximal four of these are subequal, the apical seta is reduced. At the proximal corner of the medial margin originates a sixth short slight seta.

The second legs consist of bimerous protopodites and trimerous rami. The coxopodites are yoked by a well-developed intercoxal plate. Each coxa bears at the medial distal corner a fairly robust seta which extends to about the base of the second segment of the endopodite. There is a reduced seta inserted near the lateral margin of the basipodite. The two basal segments of the exopodite are markedly contracted proximally and expanded distally. Each bears a slender, short, lateral spine and a medial seta. Each spine is accompanied by a proximally placed, stout, spinous projection of the margin of the segment. The terminal segment is somewhat less constricted basally. It bears three lateral marginal spines, two apical setae, and four medial setae. All the spines are so slender as to approach setiform dimensions, except for their reduced length.

The segments of the endopodite are constricted basally. The proximal segment bears one medial seta and the second segment bears two medial setae. The ornamentation of the distal segment consists of three medial setae, two apical setae, and one seta set at about the midpoint of the lateral margin. The insertions of the lateral apical seta and the lateral marginal seta and the distal lateral corners of the two proximal segments are ornamented by stout spinous projections of the integument.

The coxopodites of the third legs are joined by a well-developed intercoxal plate. At the distal medial corner of each coxa there is inserted a well-developed seta extending to about the base of the second segment of the endopodite. There is a reduced seta inserted near the lateral margin of the basipodite. The two proximal segments of the trimerous exopodite each bear a short, slender, lateral spine and a medial seta. The ornamentation of the terminal segment consists of three lateral spines, a weak apical spine much modified to present a markedly setiform aspect, an apical seta, and four setae inserted on the medial margin.

The armature of the three segments of the endopodite consists of one medial seta on the basal segment, two medial setae on the second segment, and three medial setae, two apical setae, and one lateral seta on the distal segment.

The fourth legs (fig. 2,*k*) consist of bimerous protopodites and trimerous rami. The intercoxal plate is much shorter than wide. At the distal medial corner of the coxa is inserted a seta which extends to about the midpoint of the first segment of the endopodite. A minute seta is inserted near the lateral margin of the basipodite.

The two proximal segments of the exopodite bear each a medial seta and a lateral spine. These spines and those of the distal segment are much reduced, pronouncedly modified in the direction of setiform structure. They taper uniformly to extremely fine points, and offer no differentiating features from setae on a structural basis. The distal segment bears two such short lateral spines, a somewhat longer apical spine and an apical seta, and four medial marginal setae.

The proximal segment of the endopodite bears one medial seta. The second segment bears two medial setae. The distal segment bears two medial marginal setae, two apical setae, and one seta on the lateral margin.

Vestigial legs and caudal rami: The bimerous fifth legs (fig. 2,*l*) are much reduced. The basal segment is produced distally at the lateral corner to form a considerable rectangular prominence on which is inserted a seta. The short, bluntly conical second segment is small, exceeded considerably by the projection of the basal segment.

There is a single short seta borne at the medial distal corner of the terminal segment.

The caudal rami are about five times as long as their basal width. They taper slightly to the somewhat rounded truncate apex. The margins are heavily ciliated. Four setae form a fanlike array across the distal margin of the ramus. The central setae of the quartet are the longest. They are subequal and their length slightly exceeds that of the ramus. The medial and outermost setae are subequal, about half the length of the long setae. On the dorsal surface of the ramus there are inserted two reduced setae. One is just subapical, near the medial margin. The other is on the lateral margin and displaced from the end of the ramus by a distance slightly exceeding the terminal width.

Male (fig. 2,*n*): The male is of the generalized notodelphyid type. The antennules (fig. 2,*n*) are modified as clasping structures. Otherwise the appendages conform well to those in the female, except for the presence of the small sixth legs absent in the female.

Remarks: In life this species is distinctively colored, with the body flesh to orange-brown and the egg masses dark green. In the transparent bodies of their hosts, some of these copepods may be detectable by superficial examination. The usual infestations are in considerable numbers, usually including juveniles as well as adults. A marked tolerance of the situation of the host is indicated, as specimens have been taken from tunicates ranging from intertidal occurrence to a collection obtained by dredging in 105 fathoms.

Indeterminable Species

Notodelphys ascidicola Allman

Notodelphys ascidicola Allman, 1847a, pp. 2–6, pl. 1, figs. 1–14, pl. 2, figs. 16–20, 22 (part, not figs. 12, 15, 21) (type locality, British Isles, in *Ascidia communis*); 1847, p. 74.—Baird, 1850, pp. 238–239.—Thorell, 1859a, pp. 5, 6, 46, 59; 1859b, pp. 336–337; 1860, pp. 114, 115, 116.—Claus, 1860, pp. 229–233, pl. 6, figs. 1–8.—van Beneden, 1861, p. 146.—Gerstaecker, 1863, p. 404.—Norman, 1869, p. 299.—Gerstaecker, 1870–1871, pp. 776, 801.—Hartmeyer, 1911, p. 1735.—Schellenberg, 1922, p. 227.

Notodelphys antarctica Brady

Notodelphys antarctica Brady, 1910, p. 568, figs. 1–8, text fig. 55 (type locality, Gauss-Station).—Schellenberg, 1922, p. 227.—Sewell, 1949, pp. 154, 174.

Notodelphys matronalis Leigh-Sharpe

Notodelphys matronalis Leigh-Sharpe, 1934, pp. 4–6, figs. 1, 2 (type localities, Salomakië, Gebé Island, in *Ascidia rhabdophora* Sluiter, *Styela asymmetrica* Sluiter).—Lang, 1949, p. 6—Sewell, 1949, p. 163.

Genus *Notodelphyopsis* Schellenberg

Notodelphyopsis Schellenberg, 1922, p. 237 (type species, by monotypy, *N. falciferus* Schellenberg, 1922).—Gurney, 1927, p. 481.—Wilson, 1932, p. 599.—Sewell, 1949, p. 174.
Notodelphys Lang, 1948, p. 5 (part).

The collection of a compressed notodelphyid exhibiting many of the characters of the genus *Notodelphys* in the features of the appendages brought forth a problem in generic assignment. The correspondence to the genera *Paranotodelphys* and *Notodelphyopsis* of Schellenberg was so close that it was concluded that, despite its habitus, it must be classified near these depressed examples of the group. The obtaining of a specimen which showed close correspondence to *Notodelphyopsis falciferus* Schellenberg, except for very minor details, has made possible a closer comparison and it is felt a satisfactory grouping can be made. The profoundest difference between *Paranotodelphys* and *Notodelphyopsis* is in urosomal segmentation. In *Paranotodelphys* there are five segments, with no fusion of thoracic and abdominal elements. In *Notodelphyopsis* there are four urosomal segments, the first of which is a genital complex, probably formed by fusion of the most posterior thoracic and most anterior abdominal somites.

DESCRIPTION: The body habit is variable, in the known forms ranging from compression to depression, with secondary inflation. The antennule may be of generalized type and 9-segmented, or highly modified and 7-segmented. The antenna is a modified trimerous structure, closely corresponding to that found in *Notodelphys*, with the same ornamentation of two plumose setae borne on the basal segment, and other conformity of details. The mandible is much like that of *Notodelphys*, with no important difference in the masticatory lamella, and with similar arrangement and setation of the palp. In the maxillule the exopodite bears four setae, the endopodite may have five or six setae. The maxilla is of generalized type. The second segment bears a conspicuously developed falcate hook-process. The maxilliped is trimerous, with only the first and third segments setiferous. The distal segment bears two or three subequal plumose setae. This appendage is distinctive in this character. The swimming legs are only specifically modified, with some elaborate specializations, but the basic pattern is generalized. The fifth legs are weakly developed bimerous appendages, much like those in *Notodelphys*, or they may be lacking.

The male is known only for the new species proposed below, so the range of generic variation can not be established.

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Key to the species of *Notodelphyopsis*

1*a*. Body depressed, antennule 7-segmented, fifth legs absent.
falciferus (p. 512)
1*b*. Body compressed, antennule 9-segmented, fifth legs present.
perplexa (p. 512)

Species not known from North America

Notodelphyopsis falciferus Schellenberg

Notodelphyopsis falciferus Schellenberg, 1922, pp. 237–239, figs. 17–20 (type locality, Sharks Bay, Australia, in *Ascidia gemmata* Sluit.).

Distribution: Australia.
Host: *Ascidia gemmata* Sluit.

North American Species

Notodelphyopsis perplexa, new species

Figure 3

Types: Holotypic female, USNM 92810 (type locality, off San Nicolas Island, Calif., from *Ascidia clementea* Ritter); allotypic male, USNM 92811, and paratypes from the same lot of specimens.

Specimens examined:

California
From *A. clementea:*
Off San Nicolas Island, Apr. 13, 1904, dredged, 1,084–1,110 fms., U. S. Fish Comm. Steamer *Albatross*, holotypic female, allotypic male, 12 female and 6 male paratypes.

Description: Female (fig. 3,*a–p*): General features: The markedly compressed body (fig. 3,*a*) is 9-segmented. The metasome consists of a head-segment bearing antennules, antennae, mouthparts and maxillipeds, three somites bearing the first three swimming legs, and an incubatory segment bearing fourth and fifth swimming legs. Articulated on this metasome is a 4-segmented urosome, including no pedigerous somite. The proximal segment is a genital segment, of marked cyclopoid aspect, almost as long as the combined remaining segments. There are three subequal posterior segments, including the telson. The caudal rami are one and a third times as long as the anal segment.

The rostrum is narrow and elongate, tapering in the distal third to form a fairly acute apex.

Head appendages: The antennule (fig. 3,*b*) is 9-segmented, although there remain indications of subdivision of segments 3 and 4. The posture of the antennule is characteristic, forming a distinct angle of almost 90°. This is due to actual curvature of the second segment to form an elbow bend. With accompanying slightly diagonal articulations of the first and third segments on the second, the near-

right-angled flexure is achieved. The two basal segments are the greatest in diameter and exhibit a slight taper distally. The succeeding three segments diminish in diameter distally in telescope fashion. The terminal three segments are aligned with a very slight uniform taper.

The lengths of the proximal six segments are nearly subequal, the tapered diameters furnishing the considerable differentiation of the proportions. The first segment is wider than long, the second just slightly longer than wide. The sixth segment is nearly three times as long as wide. The distal segments are nearly equally long and, in each, the width is just slightly exceeded by the length.

The setation of the antennule is profuse. The setae are slender and in the present specimen fall into graceful curves and spirals. The outer margin of curvature of the appendage is the setiferous margin.

The antenna (fig. 3,*c*) is trimerous. The distal segment is the longest and is articulated by a very mobile elbow joint with the basal portion which forms an apparently firmy integrated member with a diagonal articulation which approaches actual fusion. The basal joint is longer than the second. The distal extremity of the first joint lies on the inside of the right-angled flexure in which the limb apparently normally falls. At this distal point originate two long, equal, profusely plumose setae. The second segment tapers somewhat to the elbow joint. The inner margin is convexly expanded. The outer margin is nearly linear to a level at about the distal third of its extent where there is a slight emargination. Here is set a short slender seta.

The margins of the distal segment are sinuate and only roughly parallel, although in the main the aspect of the segment is linear. The terminal articulated hook is curved and slender. It is accompanied by a number of subequal setae inserted in a longitudinal row. There are two small setae borne on the end of the segment also. Midway on the segment there are borne two setae, mainly closely appressed to the surface of the segment. At the proximal quarter of the outer margin is inserted a short slender seta. The distal inner margin of the segment bears a row of spinules which continues diagonally over the surface of the segment.

The mandibles consist of a short coxal segment produced medially as a toothed masticatory plate (fig. *3,d*) and an expanded basis supporting the two rami (fig. *3,e*). The armature of the basis is a single seta inserted at about the distal third of the medial margin. The endopodite is basically 2-segmented, although the proximal line of articulation is approaching obsolescenece. The distal medial corner of the proximal segment bears three setae. The apical segment is

FIGURE 3.—*Notodelphyopsis perplexa*, new species. *a–p*, Female: *a*, habit, lateral view; *b*, antennule; *c*, antenna; *d*, masticatory lamella of mandible; *e*, palp of mandible; *f*, maxillule; *g*, maxilla; *h*, maxilliped; *i*, first leg; *j*, exopodite of second leg; *k*, endopodite of second leg; *l*, exopodite of third leg; *m*, endopodite of third leg; *n*, exopodite of fourth leg; *o*, endopodite of fourth leg, *p*, caudal ramus. *q–r*, Male: *q*, antennule; *r*, somites of fifth and sixth legs, left side. The scale, referring to *a*, represents 0.5 mm.

about as broad as wide and exhibits a slight distal flare. The armature consists of nine setae arranged around the distal half of the segment.

The exopodite is monomerous with the appearance of a short truncated cone. Three long setae orginate, with very closely spaced bases, on the apex. Two additional setae are spaced at subequal intervals along the medial (or distal) margin.

The maxillule (fig. *3,f*) consists of an obscurely segmented protopodite and two well-developed rami. The proximal portion of the protopodite bears medially an expanded setiferous endite. The seven setae comprise a very close-set group of six at the distal medial margin of the endite and a single seta considerably removed proximally and laterally from the group. There is a weakly developed seta-like medial member which seems to be a second endite. The epipodite is represented by a long seta. The terminal portion of the protopodite, probably basis, bears three markedly subequal setae on the medial margin.

The endopodite is rather narrower than long and is ornamented with six setae. Four are set in a row along the whole of the somewhat diagonally truncate distal margin. A fifth is slightly subterminal and the sixth is inserted at about the midpoint of the medial margin.

The four large, nearly equal setae of the exopodite are set in a close-spaced row along the distal margin of the single segment.

The maxilla (fig. *3,g*) is pentamerous with indications of subdivision of the protopodite. The medial margin of the protopodite is produced as four variously developed endites. The most proximal endite is a fairly conspicuous conical protuberance supporting three apically inserted setae. The second endite is represented by a single, nearly sessile seta. The third endite is less reduced; its ornamentation comprises two equal setae. The fourth endite is a rectangular process slightly longer than wide. Apically it supports two equal setae. There is a reduced accessory setule inserted just proximal to the insertion of the more basal seta.

The second segment is produced medially into a heavily sclerotized falcate spine. Basally this exceeds any of the setae of the appendage but the distal three-fourths are as slender as the accompanying setae. The length of the spine is about an eighth less than that of the longest setae of the appendage. The tip of the spine is a clearly defined sclerotized point. Accompanying this spinous process is one long, very well-developed seta and a considerably slighter seta. The latter is about an eighth shorter than the spine and its thickness is about a fourth that of the major seta.

The succeeding two segments are wider than long and each bears a medial distal seta. The terminal segment bears three setae apically inserted with their bases very close together.

The maxilliped (fig. 3,*h*) is distinctly trimerous. The ornamentation of the basal segment is arranged as two groups of members. Each group is comprised of setae and of one stout, tapered spine. The proximal group is three setae and a spine. The distal group consists of four setae and a spine. The second segment is a relatively large one, its width about two-thirds that of the basal segment. The length is about one-third again as great as the width. There is no seta or spine borne on this segment. The inner margin bears a fringe of fine ciliation.

The terminal segment is small, of about one-third the extent of the second. The ornamentation consists of three terminally placed subequal setae.

Swimming legs: The protopodites of the first swimming legs (fig. 3,*i*) are connected by a well-developed intercoxal plate. Each coxa bears at the distal medial corner a long seta which extends about to the tip of the endopodite. The basipodite is roughly right-triangular, the hypotenuse represented by the distal margin. On this is set at a medial apex a long, stout spine, and the remainder of the extent mainly consists of the articulations of the rami. The spine reaches to just short of the midpoint of the terminal segment of the endopodite. There is a reduced seta borne just medial to the short lateral margin of the basis.

The three segments of the exopodite are more equivalent in size than those of the endopodite. The proximal segment is largest, the second is smallest. There are a lateral spine and medial seta borne on each of the two more proximal segments. The terminal segment bears three lateral marginal spines, a terminal spine and seta, and three medial marginal setae. The spine of the basal segment is the stoutest spine and its length about equals that of the apical spine. The shortest spine is that placed most proximally on the distal segment.

The trimerous endopodite is armed only with setae: one on the basal segment, one on the second segment, six on the terminal segment. Of these six, four are lateral, one is apical, and one is inserted in an emargination of the lateral margin which is at about the distal third of the length of that margin. The basal segment of the endopodite is produced so that its extent nearly equals that of the two remaining segments combined.

A well-developed intercoxal plate connects the protopodites of the second swimming legs. There is a well-developed seta at the distal medial corner of the coxa. There is a reduced, fine seta borne laterally on the basipodite. The rami are both trimerous, of roughly equal segments.

The two proximal segments of the exopodite (fig. 3,*j*) bear each a

lateral spine and a medial seta. The terminal segment has three marginal lateral spines, a terminal spine and seta, and four setae arranged along the medial margin.

The proximal segment of the endopodite (fig. 3,*k*) bears a single medial seta, the second segment two medial setae. Four setae are arranged along the medial margin of the terminal segment; one seta is apical; and one seta is set in an emargination slightly distal to the midpoint of the lateral margin of the segment.

The protopodite of the third leg consists of two subequal segments, basipodite and coxopodite. The coxae are yoked by the well-developed intercoxal plate. A seta of slighter dimensions than those of the rami is inserted at the distal medial corner of each coxa. There is a reduced seta inserted near the lateral margin on the basipodite.

The exopodite (fig. 3,*l*) is trimerous. The proximal two segments each bear a lateral spine and medial seta. The terminal segment bears three lateral marginal spines, a terminal spine and seta, and four setae arranged along the medial margin.

The proximal segment of the trimerous endopodite (fig. 3,*m*) bears a single medial seta. The second segment bears two medial setae. The distal segment bears four setae arranged along the medial margin, an apical seta and one seta inserted in an emargination somewhat distal to the midpoint of the lateral margin.

The coxopodites of the fourth legs are yoked by an intercoxal plate. At the distal medial corner of each coxa is inserted a seta which extends just beyond the midpoint of the second segment of the endopodite. There is a reduced seta inserted near the lateral margin of the basipodite.

The proximal two segments of the trimerous exopodite (fig. 3,*n*) each bear a lateral spine and medial seta. The terminal segment bears two spines on the lateral margin, an apical spine and seta, and four medial marginal setae.

The endopodite (fig. 3,*o*) is trimerous. The basal segment bears one medial seta. The second segment bears two medial setae. The distal segment bears five setae, two on the medial margin, two apical, one inserted in an emargination somewhat distal to the midpoint of the lateral margin.

Vestigial legs and caudal rami: The bimerous fifth legs are very reduced. The basal segment is much produced at the lateral distal corner to form a prominence bearing a single seta. The small, somewhat conical second segment bears a single apical seta.

Each caudal ramus (fig. 3,*p*) is five times as long as its greatest width and the ornamentation consists of six well-developed setae. Three setae are apical; the innermost slightly exceeds the segment in length, the more lateral two are very long and apparently pliable.

Somewhat subapically near the medial margin on the dorsal surface is inserted a short, slender seta. At about the same longitudinal level is set a distolateral seta, as stout as the inner apical seta and about as long as the ramus. Just proximal to the midpoint of each lateral margin, and clearly set on the dorsal surface, is an unusually well-developed seta, in length slightly exceeding that of the ramus. All the setae are plumose. The margins of the ramus are not ciliated.

Male (fig. 3,*q–r*): In this species the male is of the generalized cyclopoid type. The size is much smaller than in the female due to the lack of inflation related to the brood sack. The antennule (fig. 3,*q*) is geniculate with a coalescence of the terminal segments to participate in a movable hinge. Some of the more basal segments also are partially or entirely fused. The appendages otherwise conform well to the female pattern.

The urosome is 6-segmented, a marked contrast to the tetramerous condition in the female. Here, further, the articulation of the urosome is between the somites of the fourth and fifth legs. The somites of the fifth and sixth legs are considerably fused into a distinctive compound structure (fig. 3,*r*). On the anterior portion of this region are borne the bimerous fifth legs. The proximal segment of the fifth leg is much reduced but exhibits a lateral rectangular protrusion. Apically on this process a short seta is inserted. The second segment is flattened with an expanded outline. The medial margin is nearly straight, the lateral edge is almost a semicircle. At the apex is set a short slender seta.

The sixth legs are simple protrusions on the flaps covering the genital orifices. Each consists of two slight projections bearing subequal short setae.

Nomen Nudum

Notodelphyopsis variabilis Sewell, 1949, p. 174.

Genus *Doropygus* Thorell, emended

Doropygus Thorell, 1859a, pp. 43–46 (part; type species, by later designation, G. Sars, 1921, *D. pulex* Thorell, 1859a).—Claus, 1875, p. 350 (part); 1880, p. 553 (part).—Giesbrecht, 1882a, pp. 324–326 (part).—Calman, 1909, p. 103 (part).—G. Sars, 1921, p. 42 (part).—Schellenberg, 1922, pp. 238–241 (part).—Brehm, 1927, p. 490 (part).

Description and discussion of taxonomic characters: The body form in the main is little modified, varying from a compact habit tending to be somewhat globose to an opposite considerable elongation. The metasome is 5-segmented, consisting of the head, three relatively unmodified thoracic somites, and the enlarged segment containing the brood sack. All the known representatives are more or less compressed. The urosome is basically 6-segmented, composed

of two thoracic somites, including that of the fifth legs, and four free abdominal segments. The caudal rami are relatively simple, with reduced ornamentation. The rostrum is well developed.

The antennule is typically 9-segmented, with moderate to reduced ornamentation. The antenna is trimerous, usually with very sparsely developed setation.

The mandible is of very generalized type with no great tendency to specialization. The maxillule is moderately developed. The setation of the rami consists of few members. The maxilla is typically pentamerous and not markedly modified. The armature of the second segment varies from the prominent hook process of many notodelphyids to unaltered setae. The maxilliped is reduced, basically bimerous, the segmentation tending to obsolescence. The terminal segment bears two setae.

The swimming legs are typically of generalized type with a few trends toward specialization. The armature tends to become uniformly setiform in many species. The segmentation of the posterior endopodites is reduced from the trimerous to the bimerous condition in a large series of examples. The fifth legs are robust, bimerous appendages, with feebly developed armature.

Sexual dimorphism seems to occur in a transitional state in the genus *Doropygus*. In the species *D. mohri* a similarity to the considerable disparity of the sexes in *Doropygopsis* is seen. In the male, the antennule preserves traces of prehensile adaptation, as seen in the coalescence of terminal segments. The ornamentation and segmentation of the swimming legs are most unlike in the two sexes. There is even a dimorphism in the almost vestigial fifth legs. In *D. bayeri* the opposite extreme is seen. Here there is practically no expression of dimorphism in appendages except in very minor and refined details of ornamentation.

Among the representatives of *Doropygus* here studied two antithetical trends of specific differentiation were encountered. One of these has already been noted in the literature. Schellenberg (1922), in his examination of ascidicoles from all over the world, compiled an extended list of occurrences of *D. pulex* from many localities and from a long roster of hosts. He pointed out that many of these examples exhibited minor distinctive characteristics, but he did not consider the anatomical differentiation sufficient to warrant specific designation. Lang (1948) was of the opinion that Schellenberg's list was in reality a compilation of several distinct species. It seems indisputable, however, that the question will have to remain open until the influence of ecological factors upon the structures of these copepods can be appraised. Existence as commensals in different hosts can very well represent existence in extremely disparate milieus. It would be most

probable, accordingly, to encounter ecotypes in the population of an extremely eurytopic species.

A parallel instance was experienced in the present study of *D. laticornis*. Specimens were obtained over a geographic extent ranging from Massachusetts to the Gulf Coast of Florida and a very diverse array of hosts was represented. Almost every lot of copepods presented distinctive features, yet, in the aggregate, the picture seemed to resolve as an instance of random variation of a number of plastic characteristics. The extremes of structural differentiation were encountered at the geographic extremes of this distribution. However, additional host records and intervening localities provided transitional examples which made it seem unnecessary to attempt taxonomic distinctions among the assemblage. This problem, too, will await further details of ecological knowledge of the group.

A contrary tendency was in evidence in the distribution of species in western North America. An extensive series of ascidians was assembled and each of several species was accompanied by a specifically differentiated *Doropygus*. The existence of the case stated above leads to slight suspicion as to the taxonomic validity of the Western species. Here again the ecotypic problem remains to be examined. However, these forms all stand well apart in terms of the familiar criteria of specific distinction and their distribution over a generous sampling has remained constant.

The interest of the possibilities of operation of ecological factors in this pattern among the Western American species of *Doropygus* is enormously heightened by the parallel distribution of representatives of the genus *Pygodelphys* among the identical ascidian hosts. In this case the structural differentiation has been considered here as below the level of specific significance. Hence a single species is recognized as occurring in eurytopic distribution in association with nine or more host species.

Doropygus in Schellenberg's sense was obviously too inclusive. However, it is extremely difficult to subdivide the genus. A group of three of Schellenberg's species is separable with the excellent key character of the reduced fifth legs, which in their rudimentary construction, still retain an aspect strongly reminiscent of the structure in *Notodelphys*. The antennal ornamentation is consistent in these species and furnishes a second strongly differentiating character. Accordingly, *Doropygus lamellipes*, *D. antarcticus*, and *D. novae seelandius* of Schellenberg should be removed to this genus, *Pygodelphys*. The state of the antennule, antenna, and the fifth leg in *Pygodelphys* would seem to indicate derivation from the notodelphyid stock prior to derivation of the remainder of the species assigned to *Doropygus*.

A further difficulty in assigning Schellenberg's species is allocation of his *D. cylindriformis*. From the description, this form cannot be accommodated in any known genus without alteration of the generic concept, and this step is inadvisable in the absence of specimens for study. Gurney (1927) considered *D. cylindriformis* very possibly referable to *Pseudonotodelphys*. Obstacles to this inclusion would be that there is a much more reduced antenna and a less reduced mandibular exopodite in *D. cylindriformis*, with a maxilliped that would seem derivable from a more primitive condition than that in *Pseudonotodelphys*. I do not consider the compression of *D. cylindriformis* significant. The reduction to absence of fifth legs and the configuration of legs 1 to 4 are very readily derivable from the basic *Notodelphys* type. I would consider the species as best accommodated in the *Notodelphys* complex and probably deserving of generic rank. More specimens are needed for detailed study to permit final settlement of the situation, and, until further descriptive details and illustrations of the anatomical features become available, the form is here considered as a species incerta sedis.

Sars anticipated Schellenberg in recognizing the advisability of subdividing *Doropygus*. The assemblage remaining after exclusion of the *Pygodelphys* species and *D. cylindriformis* is sufficiently diverse that it is susceptible to further logical partition. The complex of species closely allied to *D. pulex* seems to form a fairly coherent group. Basic similarity in a corresponding degree of reduction of appendages would group together a series with a notably significant key character in the armature of the maxillular rami. The basic condition of four exopodite setae and three endopodite setae can be demonstrated in *D. trisetosus* and *D. spiniferus* and the process of modification is seen in the transitional phase in *D. demissus*, in the concept here adopted, where the exopodite setal number varies from four to three. A considerable series, Arctic and American, is characterized by three setae on each ramus: *D. demissus*, in the typical form, *D. laticornis*, *D. curvatus*, and the various new Western American species. In the inverse direction of modification, *D. pulex* and *D. longimatrix* exhibit the basic four exopodite setae, with reduction of the endopodite complement to two.

The maxilliped structure is consistent throughout the whole series. The mandibular palp shows graduation from an exopodite with five setae to one with four. This group of species, since it contains *D. pulex*, the type, will constitute *Doropygus*, sensu stricto. The subdivision was anticipated by Schellenberg in his proposition of a "pulex-group" (as contrasted to a "longicauda-group") for the species he considered. Unfortunately, he selected a character which does not seem to exhibit fundamental phylogenetic significance for differenti-

ating his groups. As a result, *D. longimatrix*, which has very profound affinities with *D. pulex*, was placed in the "longicauda-group" because of the relatively insignificant fact (in my opinion) that the terminal abdominal somite does not bear the caudal rami on divergent prolongations, which condition would give the usual effect, as in *D. pulex*, of a cleft anal segment.

The species remaining after exclusion of *Doropygus*, sensu stricto, present difficulty in definition as natural groups. One line of evidence uniting the species is the consistent presence in all of the basic four setae of the maxillular exopodite. In all, as well, the number of endopodite setae is variable but progresses upward from a basic count of at least six. Since in some a distinct 2-segmented condition of the endopodite is present, the appendage in such a representative as *D. longicauda* exhibits the most primitive condition found among the notodelphyids, seemingly presenting a more basic arrangement than occurs in *Notodelphys*. (In *D. longicauda* the maxilliped is also more primitive than in *Notodelphys* in preserving a more basic number, four, of setae on the terminal segment. *Pachypygus* corresponds to *D. longicauda* in both these features. Both *Pachypygus* and *Doropygopsis*, however, possess more reduced or otherwise phylogenetically advanced features in the antennules, antennae, and mandibles over the condition in *Notodelphys*.)

All of the *Doropygus* series, excluding the species of *Pygodelphys*, probably could not be derived directly through *D. longicauda* as a stem, since in most species of *Doropygus*, sensu stricto, the mandibular exopodite retains a more primitive condition than that found in *D. longicauda*. The mandibular exopodite in *D. longicauda* is an unsegmented plate (as in *Pachypygus* and other genera). Various species of *Doropygus* preserve the segmented aspect of this ramus to varying degrees, a condition I would regard as more primitive. An antecedent form of *D. longicauda* would have had to furnish the common ancestor of *Doropygus*, sensu stricto, and the present *Doropygopsis* assemblage. On this basis, *D. longicauda* represents one of the specialized species now existent in its group. A number of species are more primitive on the basis of segmentation of the mandibular exopod, but are consistent with *D. longicauda* on the basis of setation of the maxillule, and, further, furnish graduated series either with reference to ornamentation of the antenna or in arrangement of the maxilliped.

D. thorelli and *D. novemsetiferus* are very closely allied with *D. longicauda* with reference to maxilliped structure. *D. novemsetiferus* is probably the species most closely allied with *D. longicauda*. *D. thorelli* shows a trend to suppression of the middle joint of the maxilliped in an early stage. The segment is there, but without ornamenta-

tion. In *D. porcicauda* and *D. psyltus* the middle segment is suppressed, but the terminal setal complement of three, as in *D. thorelli*, is preserved. In *D. normani*, which in most features closely resembles *D. psyllus*, reduction to two terminal setae produces a maxilliped anatomically identical with that in *Doropygus*, sensu stricto. This could justifiably be held to be a perfect example of convergence, and I can think of no logical argument against constructing the series as here presented, if the descriptive details available for *D. normani* are correct. Unfortunately, the original description is not sufficiently detailed, nor the illustrations sufficiently refined to satisfy modern demands in critical comparison of anatomical features, and specimens were not available for verification in the present study.

However, a second most significant bit of evidence almost clinches the convergence theory. In *Doropygus*, sensu stricto, the urosome is a primitive one, like that of *Notodelphys* in including four free anatomically abdominal segments. Further, the thoracic segment of the fifth legs is free of the incubatorium in *Doropygus*; thus a 6-segmented urosome is present, with every anatomical segment distinct.

In *Doropygopsis* and in the *thorelli-normani* line there is a cyclopoid "genital-segment" consisting of the fused last thoracic and first abdominal segments, so that here the urosome is 5-segmented, although still including the somite of the fifth leg. *D. normani* seemingly conforms in this anatomical feature.

If Sars' generic subdivision is to be adhered to, *Doropygopsis* will accommodate the species *D. longicauda* and *D. novemsetiferus*. *Doropygella* would then include *D. thorelli*, *D. psyllus*, *D. normani*, and *D. porcicauda*.

Key to the species of *Doropygus*, based upon females

1*a*. Second segment of maxilla with stout, well-developed hook 2
1*b*. Second segment of maxilla with only setiform elements 4
2*a*. Mandibular exopodite with 4 setae . . . . **seclusus** (p. 579)
2*b*. Mandibular exopodite with 5 setae 3
3*a*. Distal segment of maxilliped distinct, well developed . . **demissus** (p. 537)
3*b*. Distal segment of maxilliped much reduced . . . . **mohri** (p. 562)
4*a*. Maxillular exopodite with 4 setae 5
4*b*. Maxillular exopodite with 3 or fewer setae 9
5*a*. Maxillular endopodite with 2 setae 6
5*b*. Maxillular endopodite with 3 setae 7
6*a*. Mandibular exopodite with 5 subequal, well-developed setae. **longimatrix** (p. 524)
6*b*. Mandibular exopodite with 4 setae, or with a fifth much reduced. **pulex** (p. 525)
7*a*. Lateral armature of exopodites 2 to 4 spines . . . . . **spiniferus** (p. 524)
7*b*. Lateral armature of exopodites 2 to 4 setae 8

8*a*. Mandibular exopodite with 4 setae . . . . **trisetosus** (p. 524)
8*b*. Mandibular exopodite with 5 setae, 1 reduced. . . . **kerguelensis** (p. 524)
9*a*. Endopodites 2 to 4 trimerous. . . . . **curvatus** (p. 524)
9*b*. Endopodites 2 to 4 bimerous 10
10*a*. Maxillular exopodite with 2 setae. . . . . **schellenbergi** (p. 574)
10*b*. Maxillular exopodite with 3 setae 11
11*a*. Basal segment of third exopodite lacking medial seta. . . . **bayeri** (p. 544)
11*b*. Basal segment of third exopodite bearing medial seta. 12
12*a*. Basal segment of antenna lacking ornamentation. . . . . **hummi** (p. 557)
12*b*. Basal segment of antenna bearing 2 subterminally inserted setae 13
13*a*. Basal segment of fourth exopodite with medial seta . . . **laticornis** (p. 530)
13*b*. Basal segment of fourth exopodite lacking medial seta 14
14*a*. Caudal rami lacking apical setae. . . . . **fernaldi** (p. 551)
14*b*. Caudal rami set with 4 apical setae . . . . **profundus** (p. 569)

SPECIES NOT KNOWN FROM NORTH AMERICA

Doropygus longimatrix **Schellenberg**

Doropygus longimatrix Schellenberg, 1922, pp. 245–246, figs. 24, 25 (type locality, Gulf of Suez, in *Pyura momus* Sav.).—Gurney, 1927, p. 480.—Sewell, 1949, pp. 169, 179.

DISTRIBUTION: Gulf of Suez.

HOST: *Pyura momus* Sav.

Doropygus spiniferus **Schellenberg**

Doropygus spiniferus Schellenberg, 1922, pp. 248–249, 265 (type locality, southwestern Australia, in *Molgula nodosa* Hartmr.).—Sewell, 1949, p. 174.

DISTRIBUTION: Southwestern Australia.

HOST: *Molgula nodosa* Hartmr.

Doropygus trisetosus **Schellenberg**

Doropygus trisetosus Schellenberg, 1922, pp. 249, 265 (type locality, New Zealand, in *Polycarpa pegasi* Mchlsn.).—Stephensen, 1927, pp. 379–381, fig. 33.—Sewell, 1949, p. 163.

DISTRIBUTION: New Zealand.

HOST: *Polycarpa pegasi* Mchlsn.

Doropygus kerguelensis **Schellenberg**

Doropygus trisetosus var. *kerguelensis* Schellenberg, 1922, pp. 249, 266, fig. 28 (type locality, Kerguelen Island, in *Molgula* sp.).
Doropygus kerguelensis Sewell, 1949, p. 174.

DISTRIBUTION: Kerguelen Island.

HOST: *Molgula* sp.

NORTH AMERICAN SPECIES

Doropygus curvatus **Gray**

Doropygus curvatus Gray, 1938, pp. 261–269, figs. 1–10 (type locality, Woods Hole, Mass., in *Styela partita* (Stimpson).—Lang, 1948, p. 6.—Sewell, 1949, p. 157.

DISTRIBUTION: Massachusetts.

HOST: *Styela partita* (Stimpson).

REMARKS: No specimens of this American species have been obtained for the present study. The original description furnishes all the details so far known about this notodelphyid.

Doropygus pulex Thorell

? *Notodelphys ascidicola* Allman, 1847a, pp. 2–6, pl. 1, figs. 1–14, pl. 2, figs. 15–22 (part).

Doropygus pulex Thorell, 1859a, pp. 46–49, pl. 6, fig. 8 (type locality, Swedish coast in *Ascidia venosa, A. canina, A. aspersa, A. parallelogramma, Cynthia lurida*); 1859b, pp. 337, 339, 341–343; 1860, pp. 116, 118, 121, 122, 123.—Hesse, 1866, pp. 55–56.—Gerstaecker, 1870–1871, pp. 775, 776, 777, 801.—Brady, 1878, vol. 1, pp. 133–135, pl. 28, figs. 1–12.—Kerschner, 1879, pp. 184–185, pl. 1, fig. 4, pl. 2, figs. 4, 5, 9, pl. 3, fig. 9, pl. 6, figs. 10–12.—Richiardi, 1880, p. 147.—Aurivillius, 1882a, p. 54; 1882b, p. 111; 1883, pp. 24, 107–108.—Giesbrecht, 1882a, p. 324.—Carus, 1885, p. 342.—Herdman, 1889, pp. 248, 249; 1891, pp. 209–210; ?1898, pp. 254, 263.—Thompson, 1889, p. 185; 1893, p. 189, pl. 17, fig. 8.—Canu, 1891, p. 472; 1892, pp. 195–196, pl. 8, figs. 11–22, pl. 9, figs. 1–3.—T. Scott, 1900, p. 386; 1901, p. 351; 1907, pp. 363–364.—Graeffe, 1902, p. 39.—Thompson and Scott, 1903, p. 255.—Brian, 1905, p. 2, pl. 4, figs. 10–12.—Norman, 1905, p. 36.—Norman and Scott, 1906, p. 202.—Norman and Brady, 1909, pp. 400–401.—Pesta, 1909, p. 259.—Smith, 1909, p. 66, fig. 33.—Hartmeyer, 1911, pp. 1734–1735.—G. Sars, 1921, pp. 42–44, pl. 20.—Schellenberg, 1922, pp. 246–248, figs. 26, 27.—Stephensen, 1929, p. 6.—Harant, 1931, p. 370.—Marine Biological Association, 1931, p. 173.—Wilson, 1932, pp. 389–390, fig. 239.—Pesta, 1934, p. 8.—Leigh-Sharpe, 1935, p. 48.—?Wilson, 1935a, p. 779.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 119, fig. 68.—Gray, 1938, p. 261.—Stephensen, 1940, p. 20.—Sewell, 1949, pp. 157, 158, 160, 161, 169, 176, 177, 178, 182, 184, 191, 192.—Lang, 1948, pp. 2, 7; 1951, pl. 1, fig. 2.

Doropygus pullus Buchholz, 1869, pp. 116–119, pl. 6, fig. 3, pl. 7, fig. 3 (type locality, Naples).—Gerstaecker, 1870–1871, pp. 775, 804.

DISTRIBUTION: Mediterranean to Norway and Sweden, British Isles; West Africa; Faroës; Atlantic coast of North America, Barbados; Japan; Ceylon; Australia; New Zealand; ?Pacific coast of North America.

HOSTS: *Alloeocarpa thilesii* Mchlsn., *Ascidia aspersa, A. canina, A. mentula, A. parallelogramma, A. plebeia, A. venosa, Ascidiella scabra, A. opalina, Ciona intestinalis, Clavellina lepadiformis, ?Corella willmeriana, Cynthia lurida* Thorell, *C. morus* Linnaeus, *Microcosmus exasperatus* Hell. var. *australis,* Herdm., *M. oligophilus* Hell. var. *wahlbergi* Mchlsn., *Molgula oculata* Forb., *M. nodosa* Hartmr., *M. papillosa* Verrill, *Phallusia conchilega, P. obliqua, P. patula, P. virginea, Polycarpa atomaria, P. goreensis* Mchlsn., *P. obscura* Hell., *P. pomaria* Sav., *P. spongiabilis* Traust., *P. variabilis, Pyura japonica* Traust., *P. spinifera* (Q. u. Q.), *P. squamulosa, P. stolonifera* (Hell.).

P. tesselata, P. *trita* Sluit., ?*Styela gibbsii*, *S. gyrosa*, *S. loveni* (Sars), *S. plicata* Lsr., *Styelopsis grossularia* van Beneden, *Tethyum plicatum*, *T. rusticum*.

Specimens examined:

Massachusetts
From ascidian:
Woods Hole, dredged in 6 fms., July 25, 1924, C. B. Wilson, 2 females.

Florida
From ?*Styela plicata* (Lesueur):
Hurricane Harbor, Biscayne Key, growing on submerged test blocks, Mar. 23, 1950, L. B. Isham, 25-plus specimens.

Bermuda
From *S. plicata:*
G. Hawes, 2 specimens.

Description: This species has been thoroughly illustrated by Canu (1892, pls. 8, 9) and G. Sars (1921, pl. 20). The American specimens conform well to the illustrations presented by Sars, except for minor features brought out in the description below.

Female: General features: The body is rather elongate, modified by the great expansion accommodating the brood sack. The pentamerous metasome includes the head, subequal free thoracic segments of the first to third swimming legs, and the inflated incubatory segment of the fourth legs. The urosome is 6-segmented. The somite of the fifth legs is apparently urosomal, although the anterodorsal portion is associated with the structure of the brood sack. The caudal rami are moderately short and simple in structure, with reduced armature. The apex of the head is produced midventrally as the well-developed rostrum.

Head appendages: The antennule is 8-segmented, with rather feebly developed setation. The two basal segments are the longest and by far the stoutest. A sharp taper brings about a graduated reduction of the mass of the proximal segments, so that the diameter of segment 6 is only a fourth or less of that of the first segment. The diameter of the two distal segments is subequal and the major differentiation of these in dimension is in length. Segment 7 is subquadrate and segment 8 is nearly twice as long as that preceding. In specimens from Florida, the antennule is 9-segmented, the terminal segment subdividing into two equal, subquadrate units. No seta of the appendage is particularly long, but the general armature is a weakly developed one for a species of *Doropygus*.

The 3-segmented antenna is slender. The basal segment is the longest and is relatively slim and linear. The second segment is relatively long, although it is the shortest segment of the appendage. The outline is mainly linear, although each margin is slightly convex. The distal segment is long and slender, the length approximating

four times the greatest width. The margins are more or less linear, the inner somewhat sinuate. The terminal articulated hook is a relatively large one. It is accompanied by two reduced setae inserted near the articulation of the hook.

The mandible consists of a 2-segmented protopodite and well-developed rami. The coxa is produced medially as the masticatory process. The basipodite is relatively short, and its armature consists of a single well-developed seta inserted terminally on the medial margin. The articulation of the endopodite is apical on the basipodite. This ramus is 2-segmented, the segments subequal and relatively good-sized. The basal segment bears a row of four graduated setae closely spaced and inserted at the medial distal corner. A complement of eight graduated setae form a marginal row, closely spaced, applied to the medial and apical margins of the distal segment. This row starts at a point on the medial margin about a fourth of the length of the segment distal from its articulation and the row extends around to the distal lateral corner of the subquadrate segment. Sars depicts a considerably more reduced setation for his Norwegian specimens.

The exopodite articulates on a wide emargination extending along the distal half of the lateral rim of the basis. The exopodite is well-developed and fairly long. It is obscurely 4-segmented. The armature consists of four well-developed setae, regularly inserted along the distal medial half and apex of the segment. All the setae of the mandible are plumose. A specimen from Woods Hole differs from the remaining American examples by the presence of a minute setule accompanying the apical seta.

The protopodite of the maxillule shows a considerable degree of coalescence, with no clear indication of the fundamental plan of its segmentation. The proximal endite is the usual flaring lobe set with a masticatory row of nine setae of varying dimensions. A second endite is represented by a narrowly triangular process extending along the apex of the proximal endite. The epipodite is reduced to a slight prominence bearing a well-developed principal seta accompanied by a rudimentary auxiliary setule. The plane of coalescence of the coxal portion of the protopodite with the basis is displaced to proceed almost longitudinally. The three long subequal setae assignable to the basipodite are inserted in a row along a truncate margin which is the distal boundary of the protopodite. The result of alteration of orientation is that both endopodite and exopodite are directed laterally. The small endopodite bears two setae. Of the four setae of the exopodite, a long proximal seta is well developed, with the remaining three somewhat reduced.

The slender maxilla is pentamerous. The protopodite is a single

segment bearing four rudimentary endites. The proximal process, doubtless representing an endite, is armed with three setae arranged in a characteristic row along a line at right angles to the axis of the appendage. Endite 2 has a single seta. Endite 3 bears a pair of equal setae. Endite 4 is the most produced and prominent and bears two subequal setae. The second segment bears two subequal setae and a vestigial setule. The distal seta, shorter and more rigid than its companion, is the homologue of the heavy claw-process of other genera. Segments 3 and 4 bear a single seta each. The terminal segment has three apical setae.

The maxilliped is obsoletely bimerous. The gnathal margin bears a proximal quartet and a distal quintet of setae. The distal, reduced segment is articulated somewhat subapically and laterally on the basal segment. The armature of the distal segment consists of two long, subequal setae.

Swimming legs: In the first legs the protopodite is extensive. The intercoxal plate is reduced almost to extinction. The coxa is ample, subquadrate; it bears a medial seta which extends slightly beyond the midpoint of the proximal segment of the exopodite. The distal margin of the basipodite is much indented to accommodate the articulations of the rami. The medial margin of the basipodite culminates in an expanded base supporting the usual articulated spine. This spine reaches to a point at about a level with the proximal third of the second segment of the endopodite. The usual lateral seta of the basipodite is fairly long and conspicuously expanded basally.

The major ornamentation of the trimerous exopodite consists of six spines and six setae. The basal segment bears a lateral spine, nearly distally directed, and a medial seta. The second segment bears a lateral spine and a medial seta. Of the four spines of the distal segment three are ranged along the lateral margin and one is apical. Of the setae of this segment, one is apical and three are inserted along the medial margin. The most basal and most distal spines are the longest and stoutest. The remaining four are subequal; that of the second segment is shortest.

The trimerous endopodite is ornamented with a single medial seta on the basal segment, a single medial seta on the second segment, and six setae on the distal segment. The disposition of these setae is as a medial row of three, two apical and one near the midpoint of the lateral margin.

The 2-segmented protopodites of the second legs are much extended. Most of the production is in the coxa. An intercoxal plate is present, but it is reduced. The inner coxal seta is a well-developed one and reaches well beyond the tip of the endopodite. The basis bears no readily detectable armature.

The exopodite is trimerous. All the elements of the armature markedly exhibit the general qualities of setae, although those in positions usually occupied by spines on appendages homologous to this are somewhat differentiated from the remainder and in the main lack the ciliation usually occurring in setae. The basal segment bears a medial typical seta and a lateral seta which occupies the position of the usual spine. The second segment bears a lateral and a medial seta. The distal segment bears three lateral setae, two apical setae, and four medial setae.

The endopodite is bimerous with strong indication of fusion of two elements to form the distal segment. The proximal segment bears one medial seta. The armature of the distal segment is composed of four setae along the medial margin, two apical setae, one seta set subterminally on the lateral margin, and one distinctly lateral seta.

The protopodite of the third leg very much resembles that in the second legs. The intercoxal plate is vestigial. The medial coxal seta is long, extending considerably beyond the endopodite. The basis bears no armature.

The armature of the trimerous exopodite consists of setae and the elongate setalike modifications of the usual spines. The basal segment bears a seta on the medial distal corner and one on the lateral distal corner. The second segment is similarly ornamented. The third segment bears three setae on the lateral margin, two apical setae, and four setae along the medial margin.

The endopodite is bimerous and the distal segment is somewhat produced. The basal segment bears a single medial seta. The distal segment has a medial row of four setae, two apical setae, one subterminal lateral seta, and a lateral seta.

The fourth legs exhibit the prolongation of the protopodites which occurs in the two preceding pairs. The intercoxal plate is indiscernible. The distal medial seta of the coxa exceeds the endopodite.

The exopodite is trimerous and the armature consists of slender setae. The basal segment bears a lateral and a medial seta. Segment 2 has a lateral seta and a medial seta. The distal segment has two lateral setae, two apical setae, and four medial setae, these eight members crowded into a compact row around the distal third of the segment.

The endopodite is bimerous. The basal segment bears a single medial seta. The distal segment bears three medial setae, three apical setae, and one lateral seta inserted at the distal third of the segment.

Short rows of minute spinules ornament the bases of some of the setae and portions of the margins of the segments of all the four pairs of swimming legs.

Vestigial legs and caudal rami: The fifth legs are bimerous. The homology of the protopodite here is not clear. The distal segment is elongate. The lateral margin is roughly linear, the medial margin is characterized by a series of emarginations. Complications of the integumentary structure form three characteristic spinule-like ornamentations of the emarginations. Two subequal setae are borne at the apex of the segment, the more medial markedly stouter and somewhat shorter. There are a few short spinules set just subapically on the median margin.

The length of each caudal ramus is roughly 4½ times its greatest width. The margins are rather smooth and there is a gentle taper to the rounded apex. There are four roughly equal, reduced apical setae. The lengths of the setae are about two-thirds the apical width of the ramus.

Male: No adult males were available in the present series of examples. Sars figured the habitus of the male and noted that in structural features of the appendages there is little disparity between the sexes.

Remarks: The recorded distribution of this species is the most widespread so far compiled for a notodelphyid. The list of hosts is also the most diverse and extensive known. Lang has pointed out that some of the variants described are probably specifically distinct forms. However, the verification of the record must await the intensive study of variation in a local population, coupled with investigation of a series representative of the extent of distribution. Present collections are too incomplete for this procedure to be followed practically as yet.

Doropygus laticornis Wilson

Figure 4

Doropygus laticornis Wilson, 1932, pp. 388–389, pl. 1, fig. c, pl. 24, figs. a-g (type locality Woods Hole, Mass., in *Molgula manhattensis* (DeKay)).—Gray, 1938, p. 261.—Pearse, 1947, pp. 8–9, figs. 32–35.—Lang, 1948, p. 6.—Sewell, 1949, p. 157.

Specimens examined:

Massachusetts

From *M. manhattensis:*

Woods Hole, July 22, 1924, C. B. Wilson, holotypic female, 5 female paratypes.

From *Styela partita* (Stimpson):

Off Martha's Vineyard, dredged in 3–12 fms., July 1875, U. S. Fish Comm., 3 females.

North Carolina

From *Styela plicata* (Lesueur):

Fisheries Institute Pier, Bogue Sound, Morehead City, from pilings near surface at low tide, Feb. 14, 1951, W. H. Sutcliffe, Jr., 60-plus females.

FLORIDA

From *S. plicata:*

Lemon Bay, Englewood, May 13, 1950, H. J. Humm, 20-plus females.

Gulf of Mexico, 3½ miles southwest of Longboat Pass, Sarasota Bay, dredged in 5–6 fms., Mar. 24, 1951, J. B. Knight, 30-plus females.

Alligator Harbor, Franklin County, Apr. 10, 1950, H. J. Humm, 5 specimens.

From *Bostrichobranchus digonas* Abbott:

Peace River estuary, Charlotte Harbor, stranded on beach, Sept. 18, 1950, J. C. Galloway, 15-plus females.

From *Molgula occidentalis* Traustedt:

Port St. Joe, November 1935, A. S. Pearse, 9 females.

DESCRIPTION: Female (figs. 4,*a–o*): General features: This species is a medium-sized *Doropygus*, considerably inflated, and with a relatively plastic body habitus (fig. 4,*a*). The integument often is very flexible, and distortion of the body in preserved specimens is commonly observed. The pentamerous metasome includes the head, three free thoracic somites, and the enlarged incubatory segment. In some specimens the brood sack has been noted to encroach considerably into the third free segment. The urosome (fig. 4,*b*) is 6-segmented, and can be dissected free of the urosome preserving attachment of the somite of the fifth legs. The caudal rami are elongate, and an extreme variant of the species has the longest rami of any American notodelphyid.

Head appendages: The obscurely 9-segmented antenule (fig. 4,*c*) is only slightly inflated basally. The first two segments are scarcely wider than long and the two together exhibit a uniform slight distal taper. The third, fourth, fifth, and sixth segments are each successively slightly diminished in width, telescope-wise. The terminal four segments participate in a fairly uniform taper from the base of the sixth segment. The articulations of the last three segments in the appendage are variable ones, with a tendency toward suppression of the last two joints. The insertion of the first segment on the head involves a wide area of articulation, which can be readily dissected away from the head with the appendage.

The armature of the antennule consists of varyingly reduced setae. From a single representative specimen the following approximation of a representative setation pattern was formulated: segment 1–3 setae: 2–12; 3–4; 4–4; 5–3; 6–3; 7–1; 8–3; 9–5. Notably stout and elongated setae are borne on the first, fifth, sixth, seventh, and ninth segments. Only two setae of the first segment, one of the second, and the long seta of the sixth segment are plumose.

The trimerous antenna (fig. 4,*d*) is stout and compact. The posture is a right-angled flexure. The basal segment is the longest. At the distal corner innermost at the flexure there is a slight prominence furnishing insertion for a pair of much reduced setules. The unorna-

mented second segment is slightly longer than wide. The outer margin is a slight convex curve. The inner margin is characterized by a semicircular bulge occupying the central half. The third segment is long and slender. Terminally articulated is a curved, tapered hook. Three setae are inserted near the base of the hook. Three more setae are inserted superficially at the distal third of the segment, near the outer margin. Near the outer margin at the proximal third is inserted a much reduced setule.

The coxopodite of the mandible (fig. 4,*e*) is produced medially to form a flattened masticatory lamella. Along the inner border of this plate are four markedly subequal tooth-like projections, a serrated blade expanse, and two short setiform projections. The basipodite and rami constitute a setiferous palp (fig. 4,*f*) with indications of segmentation considerably suppressed. A single seta is inserted on the medial margin of the basipodite slightly subterminally. The bimerous endopodite is somewhat tapered, forming in outline a truncated cone. Four setae are inserted in a distal row on the medial margin of the proximal segment. The armature of the apical segment consists of nine graduated setae arranged along the distal three-fourths of the medial margin and the whole of the distal border. A trio of these forms a rather compact lateral distal group.

The segmentation of the exopodite is much modified, with a distinctive arrangement of the four close-set setae. The unornamented basal segment is very long. The next four segments are short, much coalesced and each bears a distally inserted seta. This setiferous portion forms a terminal unit which proximally is somewhat enveloped by a flare-like expansion of the basal segment.

The protopodite of the maxillule (fig. 4,*g*) is somewhat obscurely demarcated into two segments. The basal segment bears two endites and an epipodite. The proximal endite expands to provide a long medial margin ornamented with nine variously developed masticatory setae. The second endite is a projection which furnishes a very wide insertion for a single elongate tapering setiform process. The margins of the process are ciliated. The epipodite is a subquadrate projection bearing a long, stout seta proximally and a distal reduced accessory setule.

The basipodite is produced medially as a broad lobe on which are inserted three slender, tapering, subequal setae. The endopodite bears three setae, two inserted along the distal margin and one medial. The exopodite bears three setae, inserted with close-set bases along the distal border of the ramus.

The pentamerous maxilla (fig. 4,*h*) forms in outline an elongated triangle. The medial margin of the basal segment is produced into four setiferous endites. The proximal endite bears three setae, their

bases transversely inserted in a close-spaced row. The second endite bears one seta. The third endite bears two equal setae. The fourth endite is well developed, exhibiting a subquadrate outline. Terminally inserted on it are two long, subequal setae accompanied by a setule. The second segment bears distally and medially a similar, subquadrate endite. The armature of this consists of two long setae and a reduced setule. The third segment is subquadrate in outline. Inserted at the distal medial corner is a single long seta. The fourth segment is subquadrate, with nearly parallel margins except for a slight distal medial projection furnishing insertion for a single long seta. The terminal segment is the smallest. It bears three subequal setae inserted apically.

The obscurely bimerous maxilliped (fig. 4,*i*) is a flattened, short, stout appendage. The basal segment is about 1½ times as long as wide with parallel margins. The distal medial border forms a semicircular curve. Two groups of setae are inserted medially. The basal group consists of three setae inserted on the margin. The distal group consists of four setae arranged in a row around the distal medial curve. A fifth seta is inserted on the surface of the segment just proximal to the ultimate seta of the row. The second segment is much reduced, articulated diagonally and markedly subapically on the distal lateral corner of the basal segment. There are two long setae inserted apically on the vestigial second segment.

Swimming legs: The first legs (fig. 4,*j*) consist of bimerous protopodites and trimerous rami. A well-developed intercoxal plate yokes the coxopodites. Inserted at the distal medial corner of the coxa is a long seta which extends to the distal margin of the second segment of the endopodite. The lateral marginal seta usually found on the basipodite of related species is here somewhat modified. On a greatly expanded basal half, the terminal half is set, preserving more usual setiform dimensions. Articulated on a strongly projecting base formed by the lateral distal corner of the basipodite is a stout tapered spine which reaches almost to the distal margin of the second segment of the endopodite. The basal segment of the exopodite bears a long, stout, tapered, lateral spine and a long medial seta. The second segment bears a lateral spine of about half the dimensions of that of the first segment and a medial seta. The third segment bears three nearly equal lateral spines about the size of the lateral spline on the second segment, an apical spine very slightly larger than that of the first segment, an apical seta, and three medial setae.

The two proximal segments of the endopodite each bear a medial seta. The distal segment bears three medial setae, two apical setae, and a lateral seta inserted in an emargination at about the midpoint of the edge of the segment. All setae of the first leg are plumose.

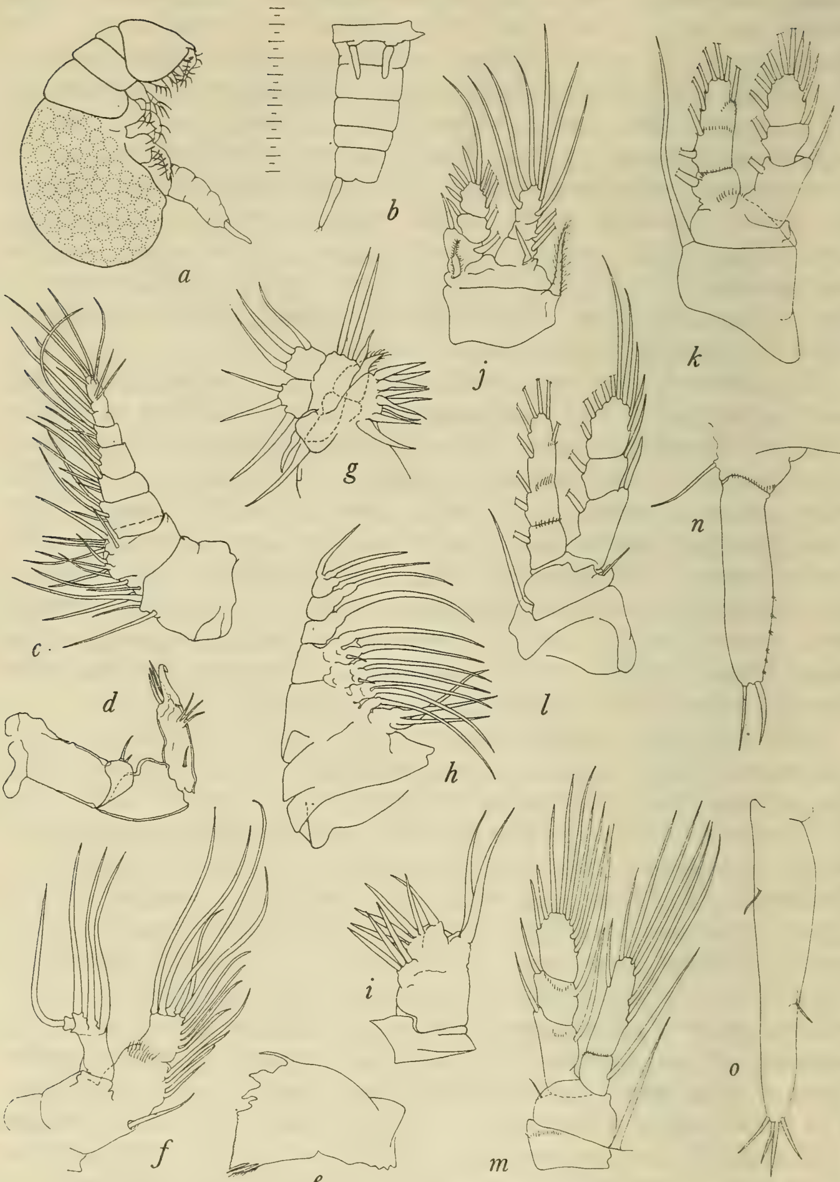

FIGURE 4.—*Doropygus laticornis* Wilson, female: *a*, habit, lateral view; *b*, urosome, *c*, antennule; *d*, antenna; *e*, masticatory lamella of mandible; *f*, palp of mandible; *g*, maxillule; *h*, maxilla; *i*, maxilliped; *j*, first leg; *k*, second leg; *l*, third leg; *m*, fourth leg; *n*, fifth leg; *o*, caudal ramus. The scale, referring to *a*, represents 1.0 mm.

The protopodites of the second legs (fig. 4,*k*) are yoked by a much reduced intercoxal plate. The coxopodites are elongated laterally so that the basal and distal articulations are divergent diagonals. Inserted on the distal medial corner of each coxa is a large, plumose seta extending well beyond the tip of the endopodite.

All the elements of the armature of the trimerous exopodite are of setiform construction, although proximally on the lateral margin these are short and somewhat rigid. All the lateral setae, the apical seta, and the one most distal medial seta lack plumose ciliation. The basal two segments each bear one lateral and one medial seta. The lateral seta of the basal segment is about equal in length to the segment. The lateral seta of the second segment slightly exceeds the segment. The distal segment bears three relatively short lateral setae, two long apical setae, and four long medial setae. All the segments of the exopodite are somewhat broadened.

The endopodite is bimerous but with strong indication of suppressed subdivision of the elongate distal segment. The proximal segment bears a single medial seta. The second segment bears five medial setae, two apical setae, and a lateral seta inserted at the distal third of the margin of the segment. Long spinules form rows on both segments of the endopodite and on the basipodite.

The third leg (fig. 4,*l*) consists of a bimerous protopodite, trimerous exopodite, and bimerous endopodite. Inserted on the distal medial margin of the coxopodite is a slender seta which extends to the proximal third of the second segment of the endopodite. The lateral marginal seta of the basipodite is reduced.

Each of the two proximal segments of the exopodite bears a short lateral seta (rather than a spine) and a medial seta. The distal segment bears three lateral setae, two apical setae, and four medial setae. All the segments of the exopodite are broadened and flattened. The basal segment is largest, nearly equaling the combined extent of the distal segment.

The endopodite extends to the level of the distal third of the exopodite. The proximal segment of the endopodite bears a single medial seta. The second segment bears five medial setae, two apical setae, and a lateral seta inserted at the distal third of the margin of the segment. A curved row of stout spinules ornaments the distal lateral corner of the first segment. A parallel row starts on the lateral margin of the second segment at the proximal one-third and continues on over the surface of the segment for most of its width. The four more proximal medial setae of the exopodite are plumose; all the setae of the endopodite except the terminal quartet are plumose.

The fourth leg (fig. 4,*m*) consists of a bimerous protopodite, trimerous exopodite, and bimerous endopodite. The segments of the protopodite are elongate and the articulation between them is displaced to run diagonally. Inserted on the distal medial corner of each coxa is a seta which extends about to the proximal fourth of the basal segment of the endopodite. The lateral marginal seta of the basipodite is somewhat reduced.

The segments of the exopodite are broadened and flattened. The basal segment is about equal to the combined extents of the two distal segments. The first segment bears a short lateral setiform spine and a medial seta. The second segment bears a similarly setiform spine and a medial seta. The third segment bears two short, lateral, setiform spines, an apical, much-elongated, heavy seta and an accompanying slender seta, and four medial setae. Only the medial seta of the first and second segments and the two proximal setae of the third segment are furnished with plumose ciliation.

The first segment of the endopodite bears a medial seta, which is slightly longer than the endopodite. The second segment bears four medial setae, two apical setae (the more lateral much shortened and rather stout), and a short stout seta inserted at the distal third of the lateral margin. A row of spinules is set along the distal lateral corner of the basal segment.

Vestigial legs and caudal rami: The fifth legs (fig. 4,*n*) are bimerous. The basal segment is unusually narrow, very slightly wider than long, tapering inward somewhat apically. On the distal medial corner and extending nearly to the lateral margin there is a row of numerous fine spinules. There is a well-developed lateral seta.

The second segment is slightly more than four times as long as wide, the slight distal taper being provided mainly by the curving lateral margin. There is a slender seta apically inserted, and slightly subterminal on the segment. At the distal point of the inner margin there is a slightly shorter, much stouter, curved seta. Five or six clusters of fine spinules are regularly arranged along the distal half of the medial margin.

The caudal rami (fig. 4,*o*) are long, slender, and markedly tapered. The apical width is a third of the basal, and the widest point of the ramus is at the proximal third. The length is five times the greatest width. There are four relatively well-developed setae arrayed across the apex. The longest of these slightly exceeds the greatest width of the segment. A seta of about half this length is inserted on the lateral margin at the proximal fourth. A similar seta is superficially inserted, nearly medially, just proximal to the terminal third.

No male was available for the present study.

Remarks: Of 19 females of this species collected at Morehead City, N. C., Feb. 14, 1951, 7 were immature in the last or next to last stadium, 12 had fully developed, empty brood sacks and the oviducts contained full-sized eggs. The eggs were rich salmon in color, closely matching the interior of the host, and the all-over color effect of the females was a flesh pink with salmon intensification along the oviduct. No coloration of the intestine was detected. Wilson recorded the color of this species at Woods Hole as yellowish.

The range of variations of this species as it occurs through its several hosts should be subjected to intensive study. An extremely great size range was noted in the present series. It seems possible that correlating other slight anatomical variations with distributional data might serve to provide a further taxonomic subdivision.

Doropygus demissus Aurivillius

Figure 5

Doropygus demissus Aurivillius, 1885a, pp. 230–233, pl. 7, figs. 14–24 (type locality, off Pitlekaj, Siberia, in *Cynthia echinata* Linnaeus); 1885b, p. 282.—Hartmeyer, 1911, p. 1734.—Schellenberg, 1922, p. 240.—Wilson, 1920, p. 14.

Specimens examined:

Siberia
From *Boltenia echinata* (Linn.):
Plover Bay, Bering Sea, U. S. Coast Survey, W. H. Dall, 3 females.

Alaska
From *B. echinata:*
Off Point Barrow Base, Aug. 30, 1949, G. E. MacGinitie, 2 females.
Off Point Barrow Base, Sept. 6, 1949, G. E. MacGinitie, 6 females.
Off Point Barrow Base, Oct. 14, 1949, G. E. MacGinitie, 1 female.
Off Point Barrow Base, Sept. 6, 1950, G. E. MacGinitie, 2 females.

The Alaskan specimens were collected by G. E. MacGinitie while working for the Office of Naval Research as Scientific Director, Arctic Research Laboratory, through contracts with the California Institute of Technology and The Johns Hopkins University.

Canada
From *B. ovifera* (Linn.):
St. Lawrence Estuary, 1929, G. Préfontaine, 8 females.

Maine
From *Ascidia prunum* Mueller:
Lat. 42°25′40″ N., long. 60°08′35″ W., dredged in 12 fms., Aug. 31, 1883, *Albatross* Station 2064, 8 females.

Description: Female (fig. 5,*a–p*): General features: This species is a large, stout, trim copepod. The body is much inflated. The 5-segmented metasome (fig. 5,*a*) includes the head, three free thoracic segments, and the greatly expanded incubatory complex. The urosome is 6-segmented. The frontal margin of the head is midventrally produced as a stout, blunt rostrum.

Head appendages: The antennule (fig. 5,*b*) is distinctly 9-segmented and relatively slender. There is a marked basal expansion but this is developed to a considerably less degree than in nearly allied species. The two proximal segments are long and of fairly uniform thickness over the combined lengths. Each of the next four segments is characterized by a marked diminution of thickness from that of the preceding segment. The seventh segment is constricted basally but its maximum width is nearly as great as that of the sixth segment. The eighth and ninth segments are about of equal width. The majority of the setae lack ciliation. However, long plumose setae form distinctive features of the first, second, fourth, fifth, and sixth segments. The plumose seta of the sixth segment is the longest and stoutest of the entire appendage.

The setation of a representative specimen provides an approximation of that usual for the species: Segment 1–3 setae; 2–10 plus; 3–5; 4–3; 5–4; 6–4; 7–2; 8–2; 9–5.

The margins of the long, slender basal segment of the trimerous antenna (fig. 5,*c*) are nearly parallel. Distally on this segment toward the inner side of the flexure of the appendage there is a short prominence with two fine filamentous apical projections which correspond to reduced setules. The second segment is slightly curved, so that its outer margin is much longer than the inner, and the articulations are somewhat diagonal. The distal portion of the inner margin expands prominently in a bulge approaching a semicircular outline. The distal segment is long and slender with nearly parallel margins. Articulated apically on this segment is a stout tapered curved hook. The hook has a characteristic, somewhat flexed posture and is terminated with a flangelike flare of the integument rather than the usual sharp point. Three rather reduced setae are inserted near the articulation of the hook. Just beyond the distal half of the segment there are inserted the close-set bases of two setae which are held closely appressed along the surface of the segment.

The coxopodite of the mandible (fig. 5,*d*) is extended medially to form a flattened masticatory blade. The inner margin of this blade is differentiated as five tooth-like prominences, a short saw-edge, and two setiform projections. The basipodite and the rami form a setiferous palp. The single seta of the basipodite is inserted subterminally on the medial margin. The basal segment of the bimerous endopodite is ornamented with four graduated setae which are arranged around the distal medial corner. The distalmost of these setae is very long and protrudes beyond the distal end of the terminal segment of the endopodite for slightly over twice again the length of that segment. Ten setae form an inverted L-shaped row along the major portion of the medial margin and all the terminal border

of the second segment of the endopodite. The exopodite is a relatively short, distinctly stocky cone, indistinctly bimerous. An apical trio of subequal setae ornaments the distal segment. A long seta is inserted at the midpoint of the anatomically medial margin of the basal segment and another seta is set at the distal medial corner of this segment.

The protopodite of the maxillule (fig. 5,*e*) presents an aspect suggesting distinct subdivision into coxopodite and basipodite. The proximal segment bears two endites and the epipodite. The basal endite is wide-flaring medially and its inner margin is armed with a close-set row of nine masticatory setae of varying proportions. Just distal to this endite, and much obscured by the overlying distal-medial flare of the basal endite, is a prominence representing the second endite. This is produced as an elongate, flat, tapering blade, expanded basally. The margins are profusely ciliated. The epipodite is represented by a slight prominence bearing a long, stout, curved seta and a reduced accessory tapering setule. The seta is proximally directed. The basipodite has the medial margin displaced distally and laterally. The lateral margin is reduced to obsolescence. There are three graduated setae inserted on the anatomically medial margin of the basis and they are directed distally. The rami are so disposed as to project almost laterally. The endopodite bears three setae, two inserted along the medial margin and one apical. The exopodite bears three stout setae inserted fan-wise along the wide outer margin in specimens examined which were found associated with *Boltenia echinata* from Point Barrow, Alaska. Specimens obtained from *Boltenia ovifera*, from the St. Lawrence estuary, Canada, were characterized by the presence of a wisp of a setule inserted between the bases of the two farthest lateral setae of the ramus (fig. 5,*f*). In specimens taken from *Boltenia echinata* from Plover Bay, Siberia, the exopodite (fig. 5,*g*) bears four well-developed setae. Otherwise specimens from the three localities correspond with each other extremely closely. The setation of the maxillular exopodite has been held as a fairly distinctive feature in notodelphyid species. The significance of the transitional series in the present material is not readily apparent.

The pentamerous maxilla (fig. 5,*h*) is a much-flattened structure with a very slender, tapering triangular outline. The basal segment is a truncated cone with the basal width roughly twice that at the distal articulation. The medial margin of this segment is elaborated into four setiferous endites. The proximal endite bears three setae with their bases transversely inserted. The second endite bears a single seta. The third endite bears two equal setae. The fourth endite is much produced and it bears two equal setae and a minute

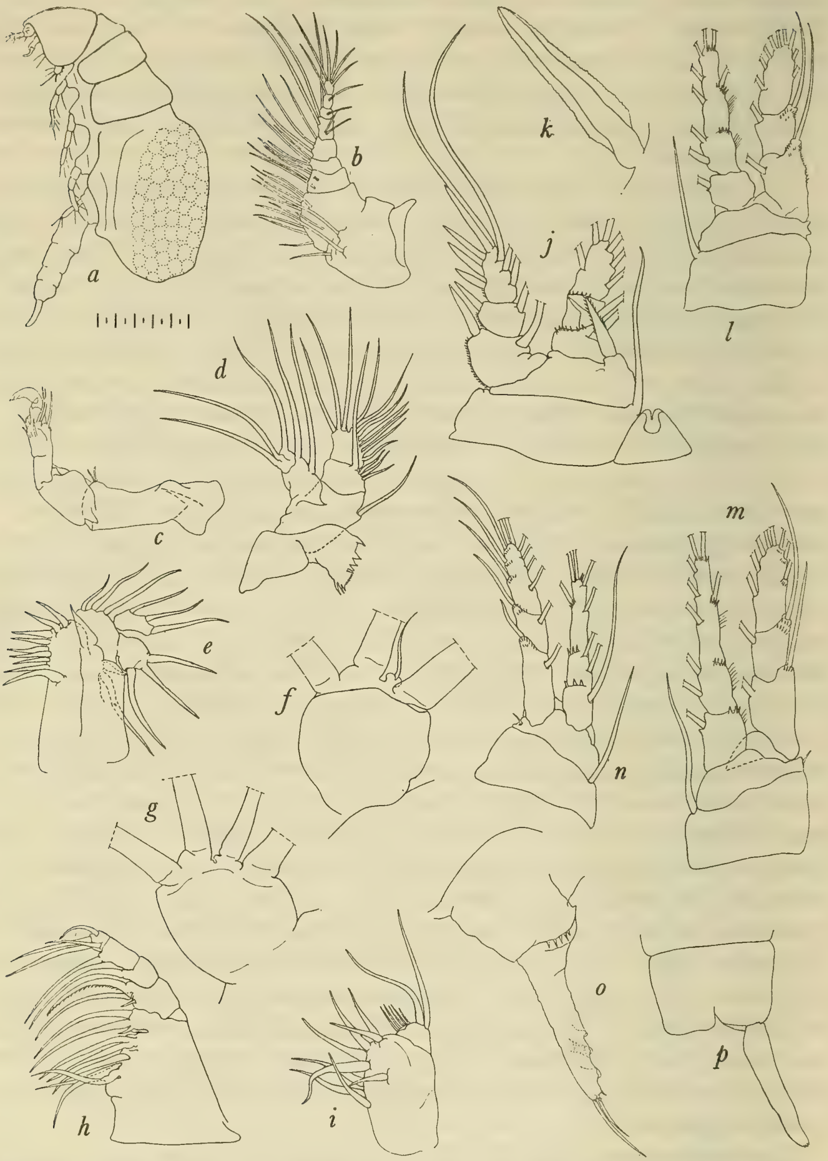

FIGURE 5.—*Doropygus demissus* Aurivillius, female: *a*, habit, lateral view; *b*, antennule; *c*, antenna; *d*, mandible; *e*, maxillule; *f*, exopodite of maxillule with rudimentary seta; *g*, exopodite of maxillule bearing four setae; *h*, maxilla; *i*, maxilliped; *j*, first leg; *k*, spine from exopodite of first leg; *l*, second leg; *m*, third leg; *n*, fourth leg; *o*, fifth leg; *p*, caudal ramus. The scale, referring to *a*, represents 1.0 mm.

accessory setule. The second segment is about as long as broad and is produced medially as a single endite. The armature of this consists of a stout, spiniform process, a typical seta, and a short accessory setule. The spiniform process, somewhat shorter than the seta, preserves in its marked sclerotization, slightly reduced length, and serrate proximal margin strong indication that it is the homologue of the usual stout hook-process of this segment in most other notodelphyid species. Each of the succeeding two segments bears a single distal medial seta. The terminal segment bears three apical setae, and a fourth seta inserted superficially near the base of the segment. The terminal complex of three segments is much elongated, the combined lengths equaling fully twice the length of the second segment. The fourth segment contributes mainly to this arrangement, its length being twice its width.

The bimerous maxilliped (fig. 5,*i*) is much flattened, short and stout in outline. The basal segment bears two groups of setae. Five setae are disposed around the distal medial margin. A second group of four setae are inserted near the midpoint of the medial margin. Displaced far laterally on the surface of the segment is the insertion of one differentiated seta in each of the two groups. These setae are stout, heavily sclerotized, disposed in a characteristic curve and ornamented with a profuse ciliation. The distal segment is a stout, short, truncated cone, articulated at the distal lateral corner of the basal segment. Its two apical setae are subequal, long, plumose. Medial to the insertion of this second segment the distal margin of the first segment is ornamented by a number of distinctive, long, stout hairs, which form a row extending to near the base of the terminal seta of the segment. The optical effect of these hairs when they are at all matted together and superficially viewed is remarkably like that of a short plumose seta inserted on the medial margin of the distal segment. Such a structure was depicted by Aurivillius in the illustrations accompanying the original description of this species. It is proposed that this feature was based upon such an error of observation.

Swimming legs: The first legs (fig. 5,*j*) consist of bimerous protopodites and trimerous rami. The coxopodites are yoked by an intercoxal plate, triangular in outline and heavily sclerotized, particularly at the apex. Inserted on the distal medial corner of the coxa is a long, profusely ciliated seta which extends to the distal margin of the endopodite. The armature of the basipodite consists of a medial spine. This spine, inserted at the distal medial corner of the basis, is stout and tapered, extending to the distal margin of the second segment of the endopodite.

The segments of the exopodite are constricted basally. The two proximal segments bear each a lateral spine and medial seta. The distal segment bears three lateral spines, an apical spine and seta, and three medial setae. The spines of the exopodite are subequal, except that the terminal spine of the distal segment is half again as long as the next longest. Each spine (fig. 5,*k*) is stout, tapered, and provided with a narrow, unusually finely serrate marginal transparent flange. The margin of each segment proximal to the insertion of the spine, or set of spines, is markedly spinulose.

The two proximal segments of the endopodite each bear a medial seta. The distal segment bears three medial setae, two apical setae, and a lateral seta which is inserted in an emargination at about the midpoint. All the setae of the endopodite are plumose. Stout spinules are set in rows along the lateral two-thirds of the distal margin of each of the two proximal segments of the endopodite.

The protopodite of the second leg (fig. 5,*l*) is produced and narrowed, with regularly transverse articulation of coxa and basis. The intercoxal plate of other species is here obsolescent. At the distal medial corner of the coxa is inserted a very long, plumose seta which extends almost to the midpoint of the distal segment of the endopodite.

The basal segment of the trimerous exopodite is elongated and bears a lateral seta and a medial seta. The second segment has a lateral and a medial seta. The distal segment bears three lateral setae, two apical setae, and four medial setae. All the lateral setae and the outer distal one are in positions usually occupied by spines, but these members are thoroughly setiform, with the only distinctive feature a slightly reduced length.

The bimerous endopodite extends slightly beyond the exopodite. The basal segment bears a single medial seta. The elongate distal segment is armed with five medial setae, two apical setae, and a lateral seta. Fine spinules provide additional armature on all the segments of the rami and on the basipodite. The three most basal medial setae of the exopodite and all but the distalmost setae of the endopodite are plumose.

In the elongated bimerous protopodites of the third legs (fig. 5,*m*) the articulation of coxa and basis is somewhat diagonal due to elongation of the outer margin of the coxa. Inserted on the medial distal corner of the coxopodite is a long plumose seta which extends to the level of the basal third of the distal segment of the endopodite. There is a reduced setule inserted near the lateral margin of the basipodite.

The segments of the trimerous exopodite are slightly broadened and flattened. The basal segment is well exceeded by the combined extents of the distal two segments. The armature consists entirely of setiform elements. The basal segment bears a lateral seta and a

medial seta. The second segment bears a lateral and a medial seta. The distal segment bears three lateral setae, two apical setae, and three medial setae.

The bimerous endopodite is about equal in extent to the exopodite. The first segment bears a medial seta. The long distal segment bears five medial setae, two apical setae, and a lateral seta inserted in an emargination just about at the distal fourth of the margin. Fine spinules arranged in curved rows and clusters furnish additional ornamentation of the appendage. The most basal setae of the medial margin of the exopodite and all but the most apical three setae of the endopodite are plumose.

The bimerous protopodite of the fourth leg (fig. 5,*n*) is elongated with a slightly diagonal articulation of the two segments produced by prolongation of the lateral margin of the coxopodite. Inserted on the distal medial corner of the coxopodite is a well-developed plumose seta reaching just about the midpoint of the endopodite. A minute reduced seta is inserted in the short lateral margin of the basipodite.

The three segments of the exopodite are flattened, but relatively slender. The basal segment is much elongated in addition so that it approximately equals the combined extents of the distal two segments. All the elements of the armature are setiform but the two most proximal lateral ones are short. The basal segment bears only a very short seta, inserted at the distolateral corner and a normally long medial seta. The second segment bears a lateral seta, relatively short, and a medial seta. The distal segment bears three lateral setae, two apical setae, and four medial setae.

The bimerous endopodite reaches about to the proximal third of the distal segment of the exopodite. The basal segment bears a single medial seta, fairly elongate, extending beyond the tip of the ramus. The second segment bears four medial setae, two apical setae, and a lateral seta inserted at the distal fourth of the margin. Curved rows and patches of fine spinules furnish additional ornamentation to the segments of the appendage. The most proximal three medial setae of the exopodite and all but the apical quintet of setae of the endopodite are plumose.

Vestigial legs and caudal rami: The fifth leg (fig. 5,*o*) is bimerous. The basal segment is longer than wide. The ornamentation consists of a short row of five or six fairly long spinules arranged on the surface of the segment near the distal medial corner. The second segment is about five times as long as its width at the midpoint, and markedly tapered. The apex is acute and is set with a slender seta. Slightly subapical and medial is a somewhat shorter second seta. Short rows of fine spinules arranged on the surface of the segment and extending to the medial margin furnish additional ornamentation.

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The caudal rami (fig. 5,*p*) are slender and relatively long, about five times as long as their greatest width. They taper only slightly distally. The ornamentation is reduced to an apical group of merest vestiges of setules.

No male has yet been found.

Remarks: The combination of circumstances presented by the distribution of this copepod and the frequently noted host, *B. echinata*, suggest strongly that it is the form described by Aurivillius from the Vega collections. There are some features of the anatomy which do not correspond with Aurivillius' figures, but the inconsistencies could well be due to the lack of detail supplied in these early sketches. The antennule of *Doropygus demissus* was depicted as 13-segmented. No *Doropygus* is known with this feature and the appendage, as depicted, could hardly be homologized with the basic notodelphyid antennule, which is a remarkably consistent structure. The form of the maxilliped was remarked upon under the description above. The remainder of Aurivillius' illustrations conform fairly well, as generalizations, to the structures of the present specimens.

Doropygus demissus has not been reported since the original description. Dr. Karl Lang, Director of the Invertebrate Collections at the Naturhistoriska Riksmuseet, Stockholm, has kindly informed me that Aurivillius' specimen is not in that museum, nor in that of Uppsala University. It is therefore concluded that this type has not been preserved. Accordingly, it seems entirely justifiable to apply the above emendations to Aurivillius' description and attach his name to these Arctic Boreal copepods.

Doropygus bayeri, new species

Figure 6

Types.—Holotypic female, USNM 92802 (type locality, Washington Sound, Washington, in *Pyura haustor* (Stimpson)); allotypic male, No. 92803, same collection, and paratypes listed below.

Specimens examined:

Washington

From *P. haustor:*

East of Upright Channel, dredged in 25–35 fms., June 22, 1950, holotypic female, allotypic male, 34 paratypes.

East of Upright Channel, 25–35 fms., June 23, 1950, 65 females.

Near Canoe Island, off Shaw Island, dredged, July 1, 1950, 43 females.

North of east end of Lopez Pass, dredged, July 15, 1950, 42 females.

British Columbia

From *Pyura* sp:

Off Cadboro Bay, dredged in 18 fms., Sept. 8, 1937, W. Williams, American Museum of Natural History 6926, 2 females.

CALIFORNIA

From *?Pyura* sp:

San Diego Bay, 6 fms., Mar. 31, 1896, *Albatross*, 18 females.

From unidentified tunicate:

Off National City, Jan. 29, 1889, *Albatross*, 8 specimens.

DESCRIPTION: Female (fig. 6,*a–n*): General features: This species is a rather small-bodied *Doropygus*, with a notable tendency to inflation (fig. 6,*a*). The segmentation is somewhat suppressed. These features, combined with the usual soft texture of the integument, frequently lead to considerable distortion in preserved specimens. The usual posture is a partially contracted one. The urosome is relatively pliable and usually lies in close conformation with the major The usual posture is a partially contracted one. The urosome is relatively pliable and usually lies in close conformation with the major mass of the body.

The anteriormost portion of the head is produced ventrally as a substantial rostrum.

Head appendages: The antennule (fig. 6,*b*) is 9-segmented and relatively slender. There is a marked basal expansion but this is developed to a considerably less degree than in nearly allied species. The two proximal segments are long and of fairly uniform thickness over the combined lengths. Each of the next four segments is characterized by a marked diminution of thickness from that of the preceding segment. The seventh segment is constricted basally but its maximum width is nearly as great as that of the sixth segment. The eighth and ninth segments are about of equal width. The majority of the setae lack ciliation. However, long plumose setae form distinctive features of the first, second, fourth, fifth, and sixth segments. The plumose seta of the sixth segment is the longest and stoutest of the entire appendage. The setation of a representative specimen provides an approximation of that typical for the genus: Segment 1–3 setae; 2–12 plus; 3–5; 4–5; 5–4; 6–4; 7–1; 8–3; 9–6.

The trimerous antenna (fig. 6,*c*) is disposed in a nearly right-angled flexure. The margins of the long, slender basal segment are nearly parallel. Distally on this segment toward the inner side of the flexure there is inserted a short stublike setule with two fine filamentous apical projections. The second segment is slightly curved, so that its outer margin is much longer than the inner; its articulations are somewhat diagonal. The distal portion of the inner margin expands prominently in a bulge approaching a semicircular outline. The distal segment is long and slender with nearly parallel margins. Articulated apically on this segment is a stout tapered curved hook. Three rather reduced setae are inserted near the articulation of the hook. At the distal sixth of the segment there are inserted the close-

set bases of two setae which are held closely appressed along the surface of the segment.

The coxopodite of the mandible is extended medially to form a flattened masticatory blade (fig. 6,*d*). The inner margin of this blade is differentiated as four tooth-like prominences, a short saw-edge, and two setiform projections. The basipodite and the rami form a setiferous palp (fig. 6,*e*). The single seta of the basipodite is inserted subterminally on the medial margin. The basal segment of the bimerous endopodite is ornamented by four graduated setae which are arranged around the distal medial corner. Nine setae form an inverted L-shaped row along the major portion of the medial margin and all the terminal border of the second segment of the endopodite. The exopodite is truncated apically with a subterminal flare, so that the base is constricted. The five setae are arranged as a close-set row across the diagonal distal margin. Segmentation of the ramus is obsolete, although there are some conspicuous grooves in the integument.

The protopodite of the maxillule (fig. 6,*f*) presents an aspect suggesting subdivision into coxopodite and basipodite. The proximal segment bears two endites and the epipodite. The basal endite is wide-flaring medially and its inner margin is armed with a close-set row of nine masticatory setae of varying proportions. Just distal to this endite, and much obscured by the overlying distal medial flare of the basal endite, is a prominence representing the second endite. This is produced as an elongate, flat, tapering blade, much-expanded basally. The margins are profusely ciliated. The epipodite is represented by a slight prominence bearing a long stout seta and a reduced accessory setule. The seta is proximally directed. The basipodite has the medial margin displaced distally and laterally. The lateral margin is reduced to obsolescence. There are three graduated setae inserted on the anatomically medial margin of the basis and they are directed distally. The rami are so disposed as to project almost laterally. The endopodite bears three setae, two inserted along the medial margin and one apical. The exopodite bears three stout setae inserted fan-wise along the wide outer margin.

The pentamerous maxilla (fig. 6,*g*) is a much-flattened structure with a slender, tapering triangular outline. The basal segment is a truncated cone with the basal width 2½ times that at the distal articulation. The medial margin of this segment is elaborated into four setiferous endites. The proximal endite bears three setae with their bases transversely inserted. The second endite bears a single seta. The third endite bears two equal setae. The fourth endite is much produced and it bears two equal setae and a minute accessory setule. The second segment is longer than broad and is produced medially as

FIGURE 6.—*Doropygus bayeri*, new species, female: *a*, habit, lateral view; *b*, antennule; *c*, antenna; *d*, masticatory lamella of mandible; *e*, palp of mandible; *f*, maxillule; *g*, maxilla; *h*, maxilliped; *i*, first leg; *j*, second leg; *k*, third leg; *l*, fourth leg; *m*, fifth leg; *n*, caudal ramus. The scale, referring to *a*, represents 1.0 mm.

a single endite. The armature of this consists of two subequal setae and a short accessory setule. The distal seta is sclerotized and slightly reduced in length. Each of the succeeding two segments bears a single distal medial seta. The terminal segment bears three apical setae.

The bimerous maxilliped (fig. 6,*h*) is much flattened, short and stout in outline. The basal segment bears two groups of setae. Five setae are disposed around the distal medial margin. A second group of four setae are inserted near the midpoint of the medial margin. Displaced far laterally on the surface of the segment is the insertion of one differentiated seta in each of the two groups. These setae are stout, heavily sclerotized, disposed in a characteristic curve and ornamented with a profuse ciliation. The distal segment is so reduced as to constitute little more than a minute setiferous prominence at the distal lateral corner of the basal segment. Its two setae are subequal, long, plumose. Medial to the insertion of this second segment the distal margin of the first segment is ornamented by a number of distinctive long stout hairs which form a row extending to the base of the most distal seta of the segment.

The first legs (fig. 6,*i*) consist of bimerous protopodites and trimerous rami. The coxopodites are yoked by an intercoxal plate, triangular in outline and heavily sclerotized in a complicated pattern. Inserted on the distal medial corner of the coxa is a long, profusely ciliated seta which extends almost to the distal margin of the endopodite. The armature of the basipodite consists of a lateral seta and a medial spine. The seta is long, stout basally with a constriction in outline at about the midpoint. It is inserted distally on the short lateral margin of the basis. The medial spine, inserted at the distal medial corner of the basis, is slender and curved, extending slightly beyond the distal margin of the basal segment of the endopodite.

The segments of the exopodite are markedly constricted basally. The two proximal segments bear each a lateral spine and medial seta. The distal segment bears three lateral spines, an apical spine and seta, and three medial setae.

The two proximal segments of the endopodite bear each a medial seta. The distal segment bears three medial setae, two apical setae, and a lateral seta which is inserted in an emargination at about the distal fourth of the segment. Rows of fine spinules form additional ornamentation on the segments of the rami and on the basipodite.

The protopodites of the second legs (fig. 6,*j*) are produced and narrowed. The articulation of coxa and basis is somewhat diagonal. A vestige of an intercoxal plate connects the basal portions of the coxopodites. At the distal medial corner of the coxa is inserted a very long, plumose seta which extends well beyond the distal margin of the

endopodite. A short seta is inserted near the short lateral margin of the basipodite.

The basal segment of the trimerous exopodite is greatly elongated and bears a lateral seta and medial seta. The second segment has a lateral and a medial seta. The distal segment bears three lateral setae, two apical setae, and four medial setae. All the lateral setae and the outer distal one are in positions usually occupied by spines, but these members are thoroughly setiform, with the only distinctive feature a slightly reduced length.

The bimerous endopodite is not quite as long as the exopodite. The basal segment bears a single medial seta. The elongate second segment is armed with five medial setae, two apical setae, and a lateral seta. Fine spinules provide additional armature on all the segments of the rami and on the basipodite.

The elongated bimerous protopodites of the third legs (fig. 6,*k*) are united by a vestigial intercoxal plate. The articulation of coxa and basis is somewhat diagonal, due to elongation of the outer margin of the coxa. Inserted on the medial distal corner of the coxopodite is a long seta which extends just beyond the tip of the endopodite. There is a reduced seta inserted near the lateral margin of the basipodite.

The segments of the trimerous exopodite are broadened and flattened. The basal segment about equals the combined extents of the distal two segments. The armature consists entirely of setiform elements. The basal segment bears a single lateral seta. The second segment bears a lateral and a medial seta. The distal segment bears three lateral setae, two apical setae, and four medial setae.

The bimerous endopodite reaches just beyond the distal margin of the second segment of the exopodite. The first segment bears a medial seta. The long distal segment bears five medial setae, two apical setae, and a lateral seta inserted in an emargination just beyond the distal fourth of the margin. Fine spinules arranged in curved rows and clusters furnish additional ornamentation of the appendage.

The bimerous protopodites of the fourth legs (fig. 6,*l*) are elongated with a diagonal articulation of the two segments produced by prolongation of the lateral margin of the coxopodite. The coxae are united by an almost obsolete vestige of the usual intercoxal plate. Inserted on the distal medial corner of the coxopodite is a well-developed seta reaching just beyond the midpoint of the endopodite. A reduced seta is inserted in the short lateral margin of the basipodite.

The three segments of the exopodite are broadened and flattened. The basal segment is much elongated in addition, so that it approximately equals the combined extents of the distal two segments. All the elements of the armature are setiform. The basal segment bears

only a single seta, inserted at the distolateral corner. The second segment bears a lateral seta and a medial seta. The distal segment bears two lateral setae, two apical setae, and four medial setae.

The bimerous endopodite reaches just to the distal margin of the second segment of the exopodite. The basal segment bears a single medial seta, considerably reduced, so as to be shorter than the distal segment. The second segment bears four medial setae, two apical setae, and a lateral seta inserted at the distal quarter of the margin. The two proximal setae are short, neither equaling the length of the segment. Curved rows and patches of fine spinules furnish additional ornamentation to the segments of the appendage.

The fifth leg (fig. 6,*m*) is bimerous. The basal segment is wider than long and articulates somewhat diagonally with the distal segment. The ornamentation consists of numerous short curved rows of fine spinules arranged on the surface of the segment near the distal medial corner. The second segment is about three times as long as its greatest width, and somewhat tapered. The apex is acute and is set with a short slender seta. Slightly subapical and medial is a second seta of about the same dimensions. Short rows of fine spinules arranged on the surface of the segment and extending to the medial margin furnish additional ornamentation.

The caudal rami (fig. 6,*n*) are short, about three times as long as their greatest width. They taper considerably distally and there is a strong tendency toward roughly spiral coiling of the apical third of the ramus. Four equal short setules are inserted on the apex. The setae are about equal in length to the width of the ramus at the insertion of the most proximal of the four setae. At the basal fifth of the ramus there is inserted near the lateral margin a fifth equally reduced seta.

Male: There is no outstandingly notable feature in the male of this species. The body of course lacks the expansion occasioned by the presence of the brood sack in the female. The antennule remarkably resembles that in the female except for the possession of a stout curved spine inserted on the outer margin of the second segment. The homologue of this member, on a considerably less developed scale, is present in the female, however. The swimming legs resemble those of the female in segmentation, but in proportion and ornamentation they are of much more generalized cyclopoid type, although still with poorly differentiated spines. The setae missing on the posterior exopodites in the female are present in the male. The urosome is modified in accordance with the presence of the reproductive structures. The sixth legs are represented by the usual bisetiferous integumentary prominences.

***Doropygus fernaldi*, new species**

FIGURE 7

TYPES: Holotypic female, USNM 92804 (type locality, Washington Sound, Washington, from *Boltenia villosa* (Stimpson)); allotypic male, No. 92805; paratypes listed below.

SPECIMENS EXAMINED:

WASHINGTON

From *B. villosa:*

Upright Channel, dredged, June 23, 1950, holotypic female, allotypic male, 5 female paratypes.

Obstruction Pass, Orcas Island, dredged, Aug. 18, 1948, R. L. Fernald, 3 females.

Upright Channel, June 23, 1950, 5 specimens.

Mitchell Bay, San Juan Island, from floats, July 12, 1950, 1 female.

Just north of east end of Lopez Pass, July 15, 1950, 1 female.

Upright Channel, dredged, July 19, 1950, 2 females.

DESCRIPTION: Female (fig. 7,*a–m*): General features: This large species (fig. 7,*a*) is relatively stout-bodied, with markedly reduced caudal rami. The metasome is distinctly 5-segmented, consisting of the head, three free thoracic somites, and the large incubatory segment. The urosome is 6-segmented and includes the somite of the fifth legs. The head is produced anteriorly at the midventral line as a conspicuous rostrum.

Head appendages: The 9-segmented antennule (fig. 7,*b*) is enormously inflated basally. The first two segments are much wider than long and the two together exhibit a uniform slight distal taper. The third, fourth, fifth, and sixth segments are each successively markedly diminished in width, telescopically. The terminal four segments participate in a fairly uniform taper from the base of the sixth segment. Various of the articulations in the appendage are very complicated ones, with a tendency toward a sleevelike overlap of the more proximal segments over the bases of those next distal. The insertion of the first segment on the head involves a wide area of articulation, sclerotized and well-delimited, which can be readily dissected away from the head with the appendage. The extent of overlapping of segments, of course, would vary with the posture of the appendage. The usual aspect in the preserved specimen has some characteristic features which can, with some validity, be compared to the condition of the antennule in other species. The basal segment overlaps about one-half the second. The second segment envelops the proximal third of segment 3. The third segment envelops about a quarter of segment 4. The overlaps of the fourth segment on the fifth and the fifth segment on the sixth are complicated diagonals, producing articulations which must involve restriction of the planes of motion of the terminal part of

the antennule. The articulations of the four terminal segments do not involve overlapping.

The armature of the antennule consists mostly of much-reduced setae. Notably stout and elongated setae are borne on the first, fifth, sixth, seventh, and ninth segments.

The trimerous antenna (fig. 7,*c*) is stout and compact. The posture is a right-angled flexure. The basal segment is the longest. At the distal corner innermost at the flexure there is a slight prominence furnishing insertion for a pair of much-reduced setules. The unornamented second segment is slightly longer than wide. The outer margin is a slight convex curve. The inner margin is characterized by a semicircular bulge occupying the central two-thirds. The third segment is long and slender. Terminally articulated is a curved, tapered hook. Four setae are inserted near the base of the hook. Three more setae are inserted at the distal third of the segment, on its surface, near the outer margin. Near the outer margin at the proximal third is inserted a much-reduced setule.

The coxopodite of the mandible is produced medially to form a flattened masticatory lamella. Along the inner border of this plate are four subequal toothlike projections, a serrated blade expanse, and two short setiform projections. The basipodite and rami constitute a setiferous palp (fig. 7,*d*). A single seta is inserted on the medial margin of the basipodite at about the distal sixth. The bimerous endopodite is much tapered, forming in outline a truncated cone. Four setae are inserted in a row around the distal medial corner of the proximal segment. The armature of the apical segment consists of ten graduated setae arranged along the distal three-fourths of the medial margin and the whole of the distal border.

The exopodite is pentamerous, with a distinctive arrangement of the five closely set setae. The unornamented basal segment is the longest. The next three segments are short and each bears a distally inserted seta. The minute terminal segment bears the remaining two setae.

Near the articulations of the maxillules and medial to their bases are a pair of well-developed paragnaths. Each paragnath reaches about to the midpoint of the protopodite of the maxillule. Each paragnath is a rounded triangle in outline. The integument is furred with fine ciliation. The sternal integument between the bases of the paragnaths is roughened by a symmetrical patch of fine scalelike denticulations.

The protopodite of the maxillule (fig. 7,*e*) is well demarcated into two segments. The basal segment bears two endites and an epipodite. The proximal endite expands to provide a long medial margin ornamented with variously developed masticatory setae. The second

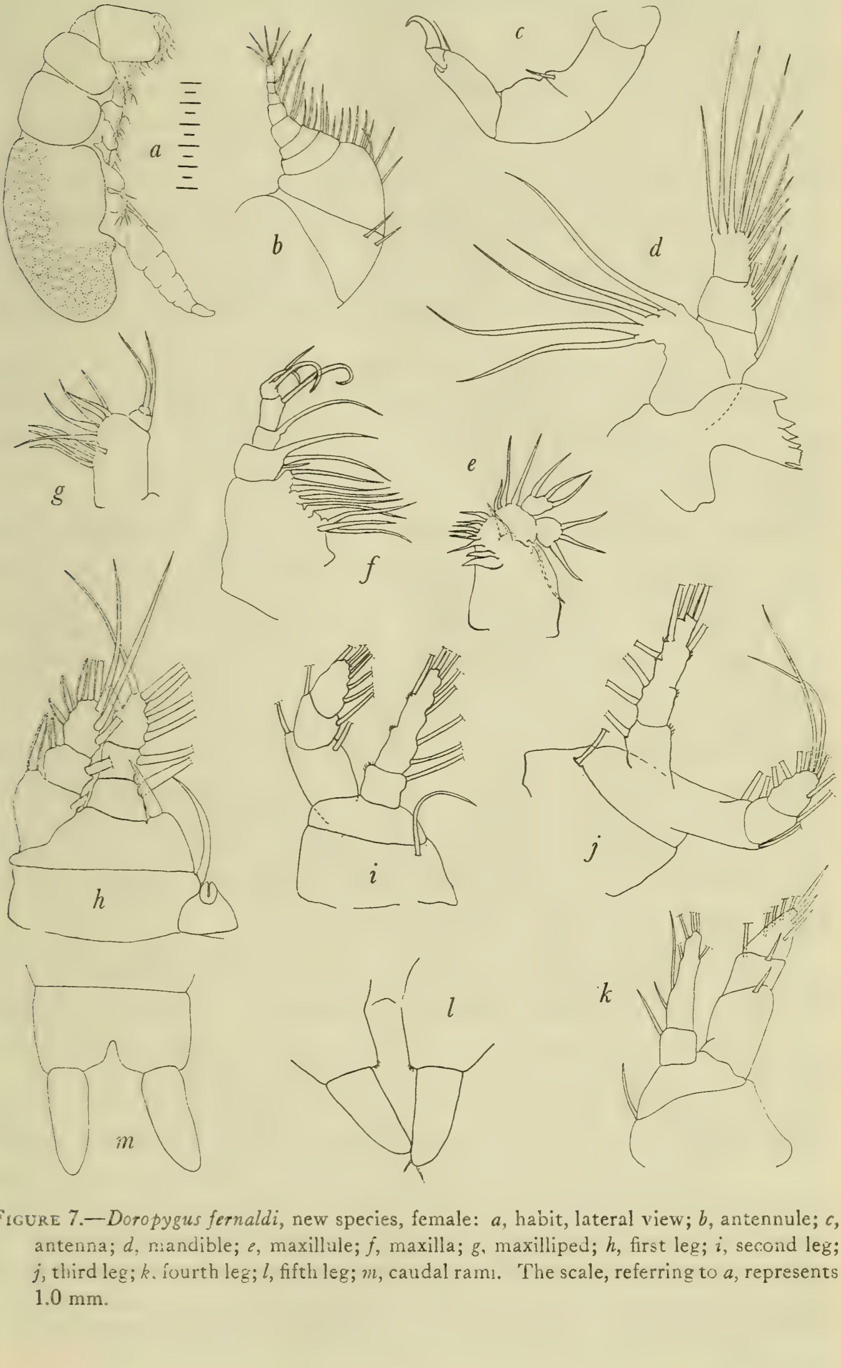

FIGURE 7.—*Doropygus fernaldi*, new species, female: *a*, habit, lateral view; *b*, antennule; *c*, antenna; *d*, mandible; *e*, maxillule; *f*, maxilla; *g*, maxilliped; *h*, first leg; *i*, second leg; *j*, third leg; *k*, fourth leg; *l*, fifth leg; *m*, caudal rami. The scale, referring to *a*, represents 1.0 mm.

endite is a projection which furnishes insertion for a single elongate tapering setiform process. The epipodite is so coalesced with the main mass of the protopodite as to constitute no more than a place of insertion for a long, stout seta and a reduced accessory setule.

The basipodite is produced medially as a broad lobe on which are inserted three long, tapering, subequal setae. The endopodite bears three setae, two inserted along the medial margin, one apical. The exopodite bears three setae, inserted with close-set bases along the distal border of the ramus. Between the bases of the two more proximal setae is a small protuberance terminating in a filamentous wisp of a setule. This structure seems to be the rudiment of a fourth seta.

The pentamerous maxilla (fig. 7,*f*) is a notably slender one so that it forms in outline an elongated triangle. The medial margin of the basal segment is produced into four setiferous endites. The proximal endite bears three setae, their bases transversely inserted in a close-spaced row. The second endite bears one seta. The third endite bears two equal setae. The fourth endite is well developed, exhibiting a subquadrate outline. Terminally inserted on it are two long, subequal setae. The second segment is produced distally and medially as an endite. The armature of this consists of a long seta and a more rigid, curved, tapering spine. The spine is of about the same diameter as the seta, but shorter, and it is somewhat more heavily sclerotized. The third segment is subquadrate in outline. Inserted at the distal medial corner is a single long seta. The fourth segment is nearly twice as long as wide, with nearly parallel margins except for a slight distal medial projection furnishing insertion for a single long seta. The terminal segment is the smallest. It bears four setae. The smallest seta is inserted proximally near the medial margin. Three subequal setae are inserted apically.

The bimerous maxilliped (fig. 7,*g*) is a flattened, short, stout appendage. The basal segment is as long as wide with parallel margins. The distal medial border forms a semicircular curve. Two groups of setae are inserted medially. The basal group consists of three setae inserted on the margin and a fourth with the articulation removed a short distance laterally to the surface of the segment. The distal group consists of four setae arranged in a row around the distal medial curve. A fifth seta is inserted on the surface of the segment just proximal to the ultimate seta of the row. The second segment is a stout truncated cone, articulated diagonally on the distal lateral corner of the basal segment. There are two long setae inserted apically on the second segment. A tuft of very fine but long cilia projects medially from the basal third of the inner margin of the second segment.

Swimming legs: The first leg (fig. 7,*h*) consists of a bimerous protopodite and trimerous rami. A well-developed intercoxal plate yokes the coxopodites. Inserted at the distal medial corner of the coxa is a long seta which extends to the midpoint of the distal segment of the endopodite. The lateral marginal seta, usually found on the basipodite of related species, is here lacking. Articulated on a strongly projecting base formed by the lateral distal corner of the basipodite is a stout tapered spine which reaches to the proximal fourth of the second segment of the endopodite. The basal segment of the exopodite bears a long, stout, tapered lateral spine and a long medial seta. The second segment bears a lateral spine of about half the dimensions of that of the first segment and a medial seta. The third segment bears three nearly equal lateral spines, slightly larger than that of the second segment, an apical spine, approaching in dimensions that of the first segment, an apical seta, and three lateral setae.

The two proximal segments of the endopodite each bear a medial seta. The distal segment bears three medial setae, two apical setae, and a lateral seta inserted in an emargination just distal to the midpoint of the edge of the segment.

The protopodites of the second legs (fig. 7,*i*) are yoked by a much-reduced intercoxal plate. The coxopodites are elongated so the length of each is about equal to the width. Inserted on the distal medial corner of each coxa is a slender seta extending to the proximal sixth of the second segment of the bimerous endopodite. Inserted at the short lateral margin of the basipodite is a much-reduced filamentous setule.

All the elements of the armature of the trimerous exopodite are of setiform construction. All the lateral setae, the apical setae, and the two most distal medial setae lack plumose ciliation. The basal two segments bear each one lateral and one medial seta. The distal segment bears three lateral setae, two apical setae, and four medial setae. All the segments of the exopodite are markedly broadened, and also inflated. This tendency is progressively increased in the posterior legs.

The endopodite is bimerous but with strong indication of suppressed subdivision of the elongate distal segment. The proximal segment bears a single medial seta. The second segment bears five medial setae, two apical setae, and a lateral seta inserted at the distal third of the margin of the segment. Long spinules form rows on both segments of the endopodite and finer spinules furnish additional ornamentation at the bases of the lateral setae of both rami.

The third legs (fig. 7,*j*) each consist of a bimerous protopodite, trimerous exopodite, and bimerous endopodite. All the elements of the armature are setiform. The usual intercoxal plate is reduced to a

vestige. Inserted on the distal medial margin of the coxopodite is a slender seta which extends to the proximal tenth of the second segment of the endopodite. The lateral marginal seta of the basipodite is reduced to a minute thread.

Each of the two proximal segments of the exopodite bears a short lateral seta and a medial seta. The distal segment bears three lateral setae, two apical setae, and four medial setae. All the segments of the exopodite are broadened and inflated. The basal segment is longest, nearly equaling the combined extent of the distal segments.

The proximal segment of the endopodite bears a single medial seta. The second segment bears five medial setae, two apical setae, and a lateral seta inserted at the distal third of the margin of the segment. A curved row of stout spinules ornaments the distal lateral corner of the first segment. A parallel row starts on the lateral margin of the second segment at the proximal one-third and continues on over the surface of the segment for half its width.

The fourth legs (fig. 7,*k*) each consist of a bimerous protopodite, trimerous exopodite, and bimerous endopodite. All the elements of the armature consist of setae, several of them of markedly reduced proportions.

The segments of the protopodite are elongate and the articulation between them is displaced to run diagonally. The intercoxal plate is reduced to a vestige. Inserted on the distal medial corner of each coxa is a much-reduced seta which extends only just beyond the midpoint of the sinuate medial margin of the basipodite. The lateral marginal seta of the basipodite is reduced to a slender but elongate cilium.

The segments of the exopodite are broadened and much inflated. The basal segment is about equal to the combined extents of the two distal segments. The first segment bears only a short lateral seta. The second segment bears a similarly reduced lateral seta and a medial seta. The third segment bears two lateral setae, two apical setae, and five medial setae. Only the seta of the second segment and the proximal medial seta of the third segment are furnished with plumose ciliation.

The first segment of the endopodite bears a much-reduced medial seta, which is about as long as the segment. The second segment bears four medial setae, two apical setae, and a seta inserted at the distal third of the lateral margin. The proximal medial seta is much reduced, only slightly exceeding in length the seta of the basal segment. A row of stout spinules is set along the distal lateral corner of the basal segment. A second parallel row starts on the lateral margin of the distal segment at its proximal third and continues over the surface of the segment for half its width.

Vestigial legs and caudal rami: The bimerous fifth legs (fig. 7,*l*) are very large. The tip of each reaches to the proximal sixth of the second urosomal segment posterior to that bearing the legs. The basal segment is wide and thick, tapering inward somewhat apically. On the distal medial corner there is a short row of a few stout, elongate spinules. There is no lateral seta.

The second segment is 2½ times as long as wide, the slight distal taper being provided mainly by the curving lateral margin. There is a slender seta apically inserted, and slightly subterminal on the segment at the distal point of the linear inner margin there is a shorter, stouter, curved seta. Five or six fine spinous projections of the integument are regularly arranged along the medial margins. The distal spinule is at the base of the medial articulated spine and constitutes the medialmost of a short row of five to six fine spinules inserted on the surface of the segment. A long row of extremely fine spinules ornaments the surface of the segment at about the proximal third.

The caudal rami (fig. 7,*m*) are very short and stout, the length equaling the greatest width. They taper regularly but slightly to the distal sixth, then terminate in a smoothly curved apex. There is no ornamentation. There is a slight ventral subapical prominence of the integument forming a toelike protrusion.

Male: The sexual dimorphism of this species is of a relatively undeveloped grade. The antennule is somewhat slenderer in the male than in the female. The swimming legs of the male are more generalized in structure and the posterior exopodites lack the marked inflation seen in those of the female. The armature of the legs of the male is much less specialized. The usual sixth legs are present as bisetiferous lobes of the seventh thoracic somite.

***Doropygus hummi*, new species**

Figure 8

Types: Holotypic female, USNM 92793 (type locality, Gulf of Mexico, off Apalachicola, Fla., in unidentified ascidian); allotypic male, No. 92794, and paratypes listed below.

Specimens examined:

Florida

From unidentified solitary ascidian:

Gulf of Mexico, off Apalachicola, lat. 28°45′ N., long. 85°02′ W., dredged in 30 fms., Mar. 15, 1885, *Albatross* Station 2405, holotypic female, allotypic male, 30 female paratypes.

Gulf of Mexico, 3½ miles southwest of Longboat Pass, Sarasota Bay, dredged in 5–6 fms., Mar. 24, 1951, J. B. Knight, 40-plus females.

Description: Female (fig. 8,*a–m*): General features: This is a minute species of *Doropygus*. The body, however, presents the usual

aspect (fig. 8,*a*) of 5-segmented metasome and 6-segmented urosome. The brood sack is not an exaggerated feature in this form and, since the eggs are relatively enormous, accommodates very few of them, generally less than 10. Instead of presenting the usually conspicuous epimera, the head and thoracic segments are inflated laterally, so that the appearance, viewed from above, is of a series of bulges of varying dimensions. The head is produced ventrally at the apex as a conspicuously developed rostrum.

Head appendages: The 9-segmented antennule (fig. 8,*b*) is much enlarged basally with a long, slender, tapering terminal portion. The two proximal segments are massive and of about equal width. Segments 3 through 6 participate in a fairly uniform taper and the elongate three terminal segments are about equal in width. The setation is profuse and the setae are fairly long and slender, mostly with well-developed ciliation. Particularly elongate setae are inserted on the sixth and ninth segments.

The three segments of the antenna (fig. 8,*c*) are unequal. The basal segment is the longest, nearly three times as long as wide and of fairly uniform width. The second segment is less than half as long as the first, about as wide. Its medial margin bows slightly outward in a gentle curve. The terminal segment is relatively short, about twice as long as its greatest width. The lateral margin is roughly linear. The medial margin tapers outward to the distal fourth then is constricted inward to the apex. A stout curved claw is apically inserted, and is accompanied by a slender seta.

The coxopodite of the mandible is expanded medially as a flattened masticatory plate. The basipodite (fig. 8,*d*) is compact. It bears a single medial seta, inserted at the distal fourth of the inner margin. The medial two-thirds of the distal extent of the basipodite affords articulation for the bimerous endopodite. The first segment of the endopodite bears three subequal setae arranged in a distal medial row. Nine setae of varying dimensions are arranged along the medial and distal margins of the second segment.

The exopodite is narrow and elongate. Five long, slender, subequal setae are arranged in a compact diagonal row along the terminal third of the ramus. Segmentation is suppressed.

The basal portion of the maxillule (fig. 8,*e*) is expanded medially as the proximal endite, along the medial margin of which are arranged eight masticatory setae. A tapered setiform structure is inserted on a more distal slight prominence representing the second endite. The epipodite is a reduced lateral protuberance bearing a long proximal seta and a distal reduced setule. The basipodite bears three long subequal setae, distally directed. The subequal endopodite and exopodite each bear three setae inserted distally.

The maxilla (fig. 8,*f*) is pentamerous with each segment produced medially in one or more setiferous protuberances. The four protuberances of the proximal segment bear respectively three, one, two, and two setae each. The second segment bears two subequal setae, the more distal only three-fourths as long as the other. The third and fourth segments bear one seta each. The fifth segment bears two subequal medially directed setae and a smaller apical seta.

The maxilliped (fig. 8,*g*) is obscurely bimerous. The bulk of the appendage is a subrectangular flattened plate. Along the medial margin seven setae are arranged as a more proximal pair and distal quintet. At the distal lateral corner a slight protuberance representing the second segment bears two long slender setae. The medial margin of the protuberance bears a row of fine hairlike cilia.

Swimming legs: The protopodites of the first swimming legs (fig. 8,*h*) are connected by a well-developed intercoxal plate. Each coxa bears at the distal medial corner a long well-developed seta which extends beyond the tip of the endopodite. On a distal medial prolongation of the basipodite is set a long, stout spine. It reaches to just beyond the proximal margin of the terminal segment of the endopodite. There is a reduced seta borne just medial to the short lateral margin of the basis.

The three segments of the exopodite are more or less equivalent in size. The proximal segment is largest, the second is smallest. There are a lateral spine and medial seta borne on each of the two more proximal segments. The terminal segment bears three lateral marginal spines, a terminal spine and seta, and three medial marginal setae. The spine of the basal segment is the stoutest spine and its length about equals that of the apical spine. The remaining spines are subequal and very little smaller.

The trimerous endopodite is armed only with setae; one on the basal segment, one on the second segment, and six on the terminal segment. Of these six, three are lateral, one is apical, one subterminal laterally, and one is inserted in an emargination of the lateral margin which is at about the proximal third of the length of that margin.

A very reduced intercoxal plate connects the protopodites of the second swimming legs (fig. 8,*i*). There is a well-developed seta at the distal medial corner of the coxa extending much beyond the tip of the endopodite. There is a reduced, fine seta borne laterally on the basipodite. The ornamentation of the rami consists entirely of setiform elements. The two proximal segments of the trimerous exopodite bear each a lateral seta and a medial seta. The terminal segment has three marginal lateral setae, two terminal setae, and four setae arranged along the medial margin.

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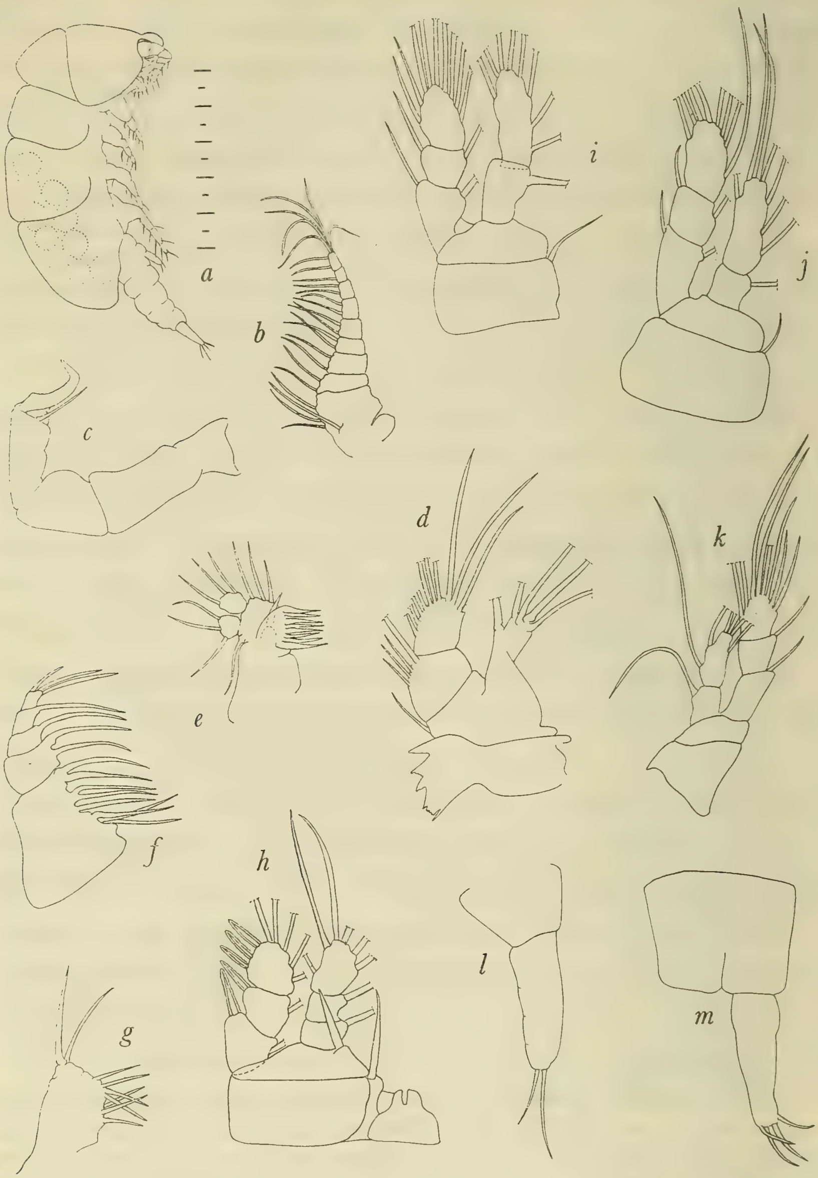

FIGURE 8.—*Doropygus hummi*, new species, female: *a*, habit, lateral view; *b*, antennule; *c*, antenna; *d*, mandible; *e*, maxillule; *f*, maxilla; *g*, maxilliped; *h*, first leg; *i*, second leg; *j*, third leg; *k*, fourth leg; *l*, fifth leg; *m*, caudal ramus. The scale, referring to *a*, represents 0.5 mm.

The proximal segment of the bimerous endopodite bears a single medial seta. Four setae are arranged along the medial margin of the terminal segment, two setae are apical, one seta is just subapical laterally, and one seta is set in an emargination at the distal third of the lateral margin of the segment. The endopodite is an unusually small one.

The protopodite of the third leg (fig. 8,*j*) consists of two subequal segments, basipodite and coxopodite. The coxas are yoked by a somewhat reduced intercoxal plate. A very elongate seta is inserted at the distal medial corner of each coxa. There is a reduced seta inserted near the lateral margin on the basipodite.

The exopodite is trimerous. All elements of the armature are setiform. The proximal two segments each bear a lateral seta and medial seta. The terminal segment bears three lateral marginal setae, two terminal setae, and four setae arranged along the medial margin.

The proximal segment of the reduced bimerous endopodite bears a single medial seta. The distal segment bears four setae arranged along the medial margin, two apical setae, a subapical lateral seta, and one seta inserted in an emargination at the distal third of the lateral margin.

The coxopodites of the fourth legs (fig. 8,*k*) are yoked by an almost obsolete intercoxal plate. At the distal medial corner of each coxa is inserted a seta which extends just beyond the midpoint of the distal segment of the endopodite. There is a reduced seta inserted near the lateral margin of the basipodite.

All the elements of the armature of the trimerous exopodite are setiform. The proximal segment bears a lateral seta and the medial seta may be present or absent. The second segment bears a lateral and medial seta. The terminal segment bears two setae on the lateral margin, two apical setae, and four medial setae.

The bimerous endopodite reaches only to the terminal segment of the short exopodite. The basal segment bears one medial seta. The distal segment bears six setae, two on the medial margin, two apical, one subapical laterally, and one inserted in an emargination at the distal third of the lateral margin.

Vestigial legs and caudal rami: The large fifth leg (fig. 8,*l*) is bimerous. The basal segment is relatively small, subrectangular, about half again as broad as long. A small seta is inserted in the distal lateral corner. The width of the terminal segment is two-thirds that of the basal. It is 3½ times as long as its basal width and tapered slightly to the rounded apex. Two subequal setae are subapically inserted. The medial seta is stouter and somewhat spiniform. Fine spinules form several short rows along the medial margin.

The caudal ramus (fig. 8,*m*) is relatively stocky. The length is slightly less than four times the basal width. There is a considerable taper distally. Four long, subequal setae are apically inserted. The length of the longest is nearly twice the basal width of the ramus. A fifth seta is inserted on the lateral margin just beyond the proximal fourth of its length.

Male: The male is of minute size. In most features there is general conformity in structure to the female, except for the presence of the sixth legs on the genital somite.

REMARKS: This species seems to be very closely related to *D. laticornis*. In most of the features of segmentation and ornamentation it conforms rather well to the latter. However, its minute size, most distinctive proportions of appendages, and reduced setation of the swimming legs furnish ample characters for satisfactory separation from the notably variable earlier species.

Doropygus mohri, new species

FIGURE 9

TYPES: Holotypic female, USNM 92814 (type locality, Puget Sound, Washington, in *Styela gibbsii* (Stimpson)); allotypic male, No. 92815, and paratypes listed below.

SPECIMENS EXAMINED:

WASHINGTON
From *S. gibbsii:*
Puget Sound, 1895, holotypic female, allotypic male.
East of Upright Head, dredged in 25–35 fms, June 23, 1950, 1 female.

DESCRIPTION: Female (fig. 9,*a–v*): General features: This rarely encountered form is a distinctly characterized one nonetheless. It is a relatively large representative among the Western American species. The body (fig. 9,*a*) is that of a robust generalized *Doropygus*. The metasome is 5-segmented, the urosome is 6-segmented. The head terminates apically in a conspicuous rostrum.

Head appendages: The antennule (fig. 9,*b*) is 9-segmented. The two basal segments are much inflated. There is a considerable diminution in measurement from the second segment to the third. There is a very sharp taper through the third through sixth segments. The terminal four segments taper gradually. The apical segment is about as long as wide. The setae are fairly well developed, but sparsely or obsoletely plumose. They are concentrated along an outer setiferous margin. The basal segment has two long stout setae at the outer distal corner, these accompanied by one or two minor setae. The second segment bears the greatest number of setae, 10 or more. Third, fourth, and fifth segments bear a small number of setae. The sixth segment is distinctive for the very long and well-developed seta

inserted at the distal outer corner. The seventh and eighth segments have few setae. The terminal segment is ornamented with six or more setae which tend in their arrangement to concentrate in an apical radiating tuft.

The antenna (fig. 9,*c*) is trimerous, with the basal segment the longest. The posture of the limb is in a characteristic right-angled flexure. At the distal corner of the basal segment internal to the flexure are inserted two minute but distinct setules. The length of the second segment but slightly exceeds its width. The segment is slightly but not markedly narrower than the first. The terminal segment is the narrowest. Inserted on the distal end in a complicated articulation is a curved stout tapered hook. Three setae are set on the distal end of the segment close to the articulation of the hook. Three setae form a compact cluster appressed on the surface of the segment at a level about a third of the length of the segment proximal to the articulation of the hook. Proximal still another third is the outer marginal insertion of a single reduced setule.

The mandible consists of a 2-segmented protopodite, a bimerous endopodite, and a tetramerous exopodite. The coxopodite is extended medially as the usual masticatory plate featured by a serrate inner margin (fig. 9,*d*). The basipodite (fig. 9,*e*) is a large segment. Near its distal medial corner is inserted a single seta. The medial half of the terminal margin of the segment is produced to form a wide articulation with the bimerous endopodite. Around the distal medial corner of the proximal segment of the endopodite is inserted a row of four setae. These are graduated markedly from a small proximal seta to an elongate distal seta. Forming a row around the distal two-thirds of the medial margin and the whole of the truncate apical border of the terminal segment are nine graduated setae. Six of these form a close-spaced row. Three have their bases closely associated on a slight distolateral prominence of the segment.

The exopodite is conspicuous, long and tapered from a broad insertion on the basipodite to a narrow apex. Each of the three proximal segments bears a long stout seta inserted at the distal medial corner. The minute apical segment bears two subequal setae terminally placed.

The maxillule (fig. 9,*f*) is characterized by a marked tendency to obliteration of obvious segmentation. The protopodite is obscurely 2-segmented. The basal portion supports two endites and a reduced epipodite. The proximal endite is expanded and conspicuous. Distally along its medial margin is inserted a row of nine setae, predominantly stout and sharply tapered, although two are slender. Just distal to this principal endite is a small projection terminating in a setiform elongation which is considered to represent a second endite.

The epipodite is represented by a long tapered seta accompanied by a minute accessory setule.

The terminal mass of the protopodite, equivalent to the basipodite, bears a medially directed distal row of three setae. Somewhat laterally oriented on the apex of the protopodite are the two reduced rami, each bearing three setae. The setae of the endopodite are inserted respectively apically and upon two emarginations of the medial border arranged in uniform step-formation. The setae of the exopodite radiate fan-wise from closely set bases along the truncate distal margin.

The maxilla (fig. 9,*g*) is pentamerous. The principal mass of the appendage consists of the basal segment which bears four setiferous prominences representing endites. The basal endite bears three setae. The second endite is represented by a single seta inserted on a very slight prominence. The third endite bears two equal setae. The fourth endite is the longest. It forms a well-demarcated quadrate mass bearing three setae. Two of these are well developed, of about equal proportions, inserted apically. Just proximal to these is set a reduced setule.

The second segment is much wider than long. Distally this segment extends in a medial prolongation which constitutes a stout, heavily sclerotized hook, about two-thirds as long as the principal setae of the maxilla. Inserted at the base of the hook are one well-developed long seta and an accessory reduced setule.

The two next distal segments are subequal in proportion with a well-discernible apical taper. Inserted prominently at the distal medial corner of each of these segments is a single long seta. The reduced terminal segment bears four setae. Three of these are subequal and their bases are close-set in an apical insertion. The fourth is the smallest and is inserted on the surface of the segment toward the basal articulation.

The bimerous maxiliped (fig. 9,*h*) is elongate and relatively slender. The medial margin bears nine setae arranged in two groups. The proximal set of setae consists of four. The distal five setae are close-set around the curved distal medial margin. Articulated subapically and far laterally is the much-reduced distal segment. It constitutes little more than an insertion for two long, approximately equally developed setae.

Swimming legs: The protopodites of the first legs (fig. 9,*i*) are conspicuously bimerous; the rami are trimerous. The coxopodites, yoked by a triangular, apically bilobed intercoxal plate, are of rectangular outline. At the medial distal corner of each coxa is inserted a long tapering seta, the tip of which reaches just beyond the distal border of the endopodite. The basipodite has a very short lateral

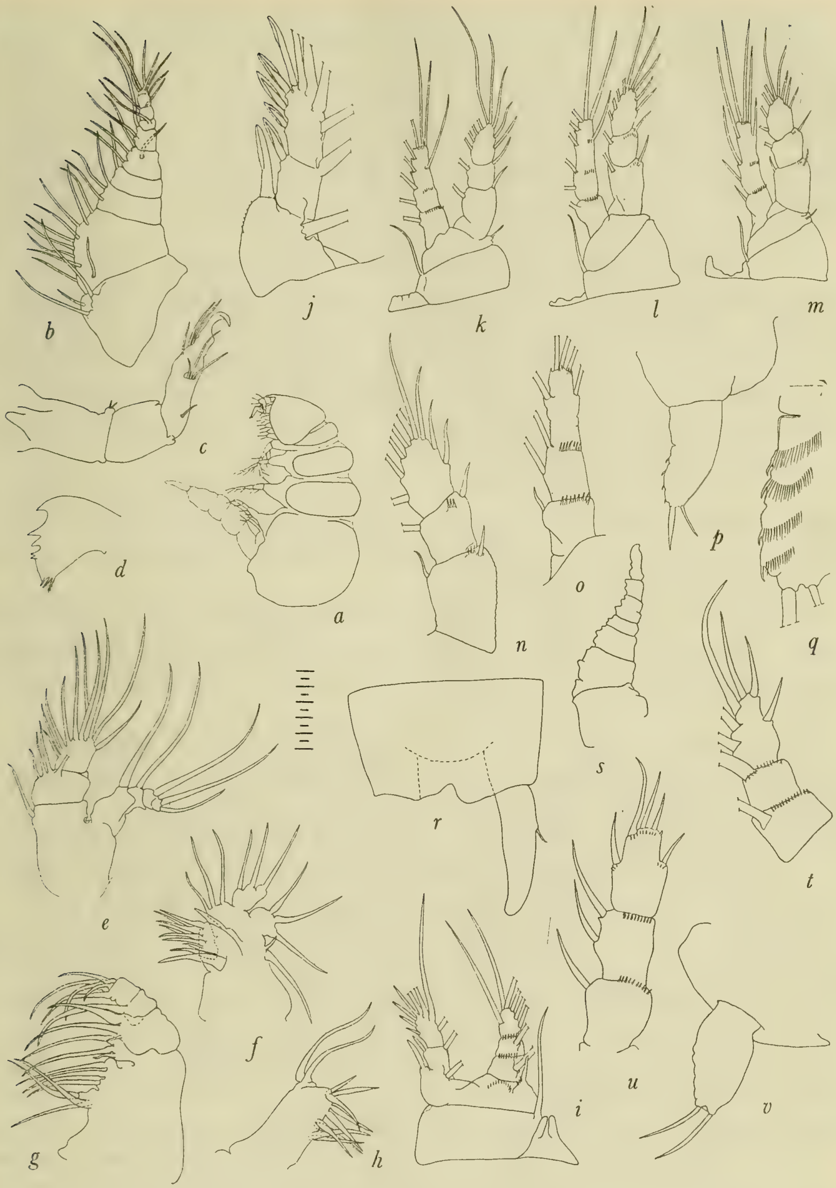

Figure 9.—*Doropygus mohri*, new species. *a–r*, Female: *a*, habit, lateral view; *b*, antennule; *c*, antenna; *d*, masticatory lamella of mandible; *e*, palp of mandible; *f*, maxillule; *g*, maxilla; *h*, maxilliped; *i*, first leg; *j*, exopodite of first leg; *k*, second leg; *l*, third leg; *m*, fourth leg; *n*, exopodite of fourth leg; *o*, endopodite of fourth leg; *p*, fifth leg; *q*, medial ornamentation of fifth leg; *r*, caudal ramus. *s–v*, Male: *s*, antennule; *t*, endopodite of first leg; *y*, endopodite of fourth leg; *v*, fifth leg. The scale, referring to *a*, represents 1.0 mm.

margin and a long diagonal articulation with the exopodite; the rest of the distal border is roughly parallel with that of the coxa. A reduced seta is inserted near the lateral margin. At the medial distal corner of the basis is articulated a well-developed tapering spine which reaches just beyond the distal border of the basal segment of the endopodite. A curved row of spinules constitute an ornamentation of the basis near the articulation of the endopodite. There are also a few spinules inserted near the base of the medial spine.

The segments of the exopodite (fig. 9,*j*) are subequal. The basal is the widest and each of the succeeding segments diminishes somewhat in width. The distal segment is longest. Each of the two basal segments bears a stout lateral spine and an elongate medial seta. Inserted on the terminal segment are three spines along the lateral margin, an apical outer spine and inner seta, and three setae along the medial border. The spine of the basal segment is the stoutest and longest. All the others are of about equal thickness. The apical spine is just slightly shorter than the basal one. The proximal spine of the third segment is the shortest. All the spines have partial or extensive transparent serrated marginal flanges.

The two proximal segments of the endopodite bear each a medial seta. The terminal segment bears three medial marginal setae, two apical setae, and a seta inserted in an emargination at about the midpoint of the lateral margin.

The second legs (fig. 9,*k*) show the initial stages of tendencies progressively developed in the succeeding two pairs of legs. The articulation of coxopodite and basipodite is somewhat diagonal so that the lateral margin of the coxa is longer than the medial margin. There is a uniting intercoxal plate, but the distal extent of this is only to about the midpoint of the medial margin of the coxa and the plate is weakly sclerotized. There is inserted on the medial distal corner of the coxa a well-developed seta which extends to a point just slightly beyond the distal border of the basal segment of the endopodite. Inserted near the short lateral margin of the basipodite is a very reduced seta.

The exopodite is trimerous. Its armature consists of the usual lateral spines and medial setae. However, the distal elements in the usual position of spines are of markedly setiform construction. There is a short slender lateral spine and a well-developed medial seta borne on each of the two proximal segments. On the distal segment there are three laterally inserted elements graduated from an elongate spiniform proximal member to a distal element approximating a seta in proportions. There are two apical setae, the lateral one much shorter and presumably representing a modified spine. Inserted along the medial border are four well-developed setae.

The endopodite is bimerous, with the elongate distal section pre-

serving traces of a fundamental segmentation. The basal segment bears one medial seta. The elongate distal segment tapers apically. It bears five marginal medial setae, two apical setae, and a single seta inserted in an emargination removed proximally about one-third the length of the segment from the apex. A short row of spinules curves across the face of the segment at the level of the second medial seta. There are also spinules at the base of the lateral and apical setae and a row of spinules on the lateral distal border of the basal segment.

The line of articulation of the coxopodite and basipodite of the third legs (fig. 9,*l*) is markedly diagonal. The medial proximal corners of the coxopodites are yoked by a rudimentary intercoxal plate, the length of which approximates only one-third its width. At the distal medial corner of the coxa is borne a seta which extends to the level of the insertion of the medial seta of the proximal segment of the endopodite. Inserted near the short lateral margin of the basipodite is a much-reduced setule.

The armature of the exopodite is a series of diverse setiform members, the laterally inserted elements which ordinarily would be spines having all the characteristics of short setae. The proximal two segments bear each a short lateral seta and a normal medial seta. The terminal segment bears three lateral setae, two apical setae, and four medial setae. The two proximal lateral setae are short and of dimensions similar to those of the basal segments.

The endopodite is bimerous. The basal segment bears a single medial seta. The distal segment, elongate, slightly tapered, and with vague indications of fundamental subdivision, bears five medial setae, two apical setae, and one lateral seta. Further ornamentation of the rami is provided by short rows of fine spinules.

The protopodites of the fourth legs (fig. 9,*m*) are produced. The line of articulation of the coxopodite and basipodite is diagonal so that the outer margin of the coxopodite is about double the length of the medial margin. The coxopodites are yoked by an intercoxal plate. This is conspicuously reduced but the outer margins are coextensive with the medial margins of the coxa. Inserted on the distal medial corner of the coxopodite is a slender seta which extends to about the midpoint of the proximal segment of the endopodite. Near the short lateral margin of the basipodite is inserted a much-reduced setule.

The armature of the trimerous exopodite (fig. 9,*n*) consists of mostly normal setae and, on the outer margins of the segments, elements which approach somewhat more spiniform construction than the corresponding setiform members of the other swimming legs.

The basal segment is elongate. It bears a short lateral spine and a very short medial seta which scarcely exceeds the spine in length. The second segment bears a lateral spine and a medial seta. The

terminal segment bears three lateral spines, considerably tending toward setiform aspect, an apical spine which closely approximates setiform proportions, an apical seta, and four setae disposed along the medial border.

The endopodite (fig. 9,*o*) is bimerous, but with the elongate second segment preserving traces of the fundamental subdivision into two podomeres. The basal segment bears a very short, reduced medial seta. The distal segment bears four setae arranged along the medial margin, two apical setae, and a lateral seta inserted in an emargination of the border of the segment opposite the insertion of the third medial seta. The lateral seta and the two more proximal setae of the distal segment are considerably reduced. A row of fine spinules ornaments the distal border of the basal segment of the endopodite and a second row curves over the surface of the distal segment at the level of the second seta. A few spinules are set at the insertions of the lateral setae of the endopodite and of the spines of the exopodite.

Vestigial legs and caudal rami: The bimerous fifth legs (fig. 9,*p*) are of reduced absolute dimensions. The basal segment is half again as wide as long and lacks ornamentation. The distal segment is 2½ times as long as its basal width. The margins are roughly parallel for slightly more than half the length, then there is a taper to the somewhat narrowed apex. The armature consists of two apically inserted elements, the more medial spiniform; the lateral a reduced seta. Along the medial side there are four projections (fig. 9,*q*) interrupting the margins. These constitute elaborations of the integument related to rows of fine spinules. Each row of spinules extends a considerable distance laterally over the surface of the segment. The spinules are fine-textured, closely appressed to the segment, and not readily obvious.

The caudal rami (fig. 9,*r*) are long, their length about six times the greatest width. The margins are nearly parallel for about one-third of the length where a distinct emargination provides insertion for a short seta. From the seta distally the ramus tapers gradually and curves slightly inward, terminating in a curved apex narrowed to about one-third of the basal width. There is no apical armature.

Male (fig. 9, *s–v*): There is a relatively strong sexual dimorphism shown in the appendages of this species for a representative of *Doropygus*. The antennule (fig. 9,*s*) retains weak indications of an obsolete prehensile function, particularly in the coalescence of terminal segments. The swimming legs are not so elongate and the armature is much reduced in length and markedly spinose (fig. 9,*t,u*). The fifth leg (fig. 9,*v*) is a much less elaborate structure than that in the female, with simplified outline and reduced ornamentation. The sixth legs are of the generalized type.

***Doropygus profundus*, new species**

FIGURE 10

TYPES: Holotypic female, USNM 92801 (type locality, off San Nicolas Island, Calif., in *Bathypera ovoidia* (Ritter)); allotypic male, USNM 92829, paratypes listed below.

SPECIMENS EXAMINED:

CALIFORNIA

From *B. ovoidia:*

Off San Nicolas Island, dredged in 1,084–1,100 fms., Apr. 13, 1904, *Albatross* Station 4425, holotypic female, allotypic male, 4 female and 4 male paratypes.

DESCRIPTION: Female (fig. 10,*a–n*): General features: The body (fig. 10,*a*) is a comparatively slender one. In the long-preserved material studied the brood sack is prolonged posteriorly as a tubular structure. Whether this is an artificiality related to the collection of the host from a great depth and long preservation before removal of the copepod is not obvious. The usual body segments are all neatly delimited, and the appendages are trim and symmetrically disposed. The anteriormost portion of the head is produced ventrally as the well-developed rostrum.

Head appendages: The antennule (fig. 10,*b*) is 9-segmented, with fairly well-developed setation. The two basal segments are the longest and by far the stoutest. The appendage forms an inflection at the joint between the fifth and sixth segments. A sharp taper brings a graduated reduction of the mass of the proximal segments so that the diameter of the fifth segment is only a fourth or less of that of the first segment. The diameter of the distal four segments is subequal and the major differentiation of these in dimension is the variety of lengths. The sixth segment is the longest of the terminal four, succeeded in rank of length by segments nine, eight, and seven. No seta of the appendage is particularly long, but the general armature is a well-developed one for a species of *Doropygus*.

The 3-segmented antenna (fig 10,*c*) is slender. The basal segment is the longest and is relatively slim and linear, with a slight distal flare. The apex of the flare provides an insertion for two reduced setae, which are extremely well developed for a *Doropygus*. The longer is about double the dimensions of the lesser one and its length is about equal to the diameter of the segment at its longitudinal midpoint. The second segment is relatively long, although it is the shortest segment of the appendage. The outer margin is linear, the inner is produced in a markedly subsemicircular convexity. Subterminally on the outer margin is set a reduced seta. The distal segment is long and slender, the length approximating four times the

greatest width. The outer margin is linear, the inner somewhat sinuate. The terminal articulated hook is a relatively slender one. The setal armature includes six apical and slightly subterminal setae, a trio of graduated setae inserted on the surface of the segment about a third of its length proximal from the tip, and a reduced seta articulated near the outer margin at about a quarter of the length of the segment from its base.

The mandible (fig. 10,*d*) consists of a 2-segmented protopodite and well-developed rami. The coxa is produced medially as the masticatory process. The basipodite is relatively short, and its armature consists of a single well-developed seta inserted subterminally on the medial margin. The articulation of the endopodite is apical. This ramus is 2-segmented, the segments subequal and relatively large. The basal segment bears a row of graduated setae closely spaced and inserted at the medial distal corner. A complement of 10 graduated setae form a marginal row, closely spaced, applied to the medial and apical margins of the distal segment. This row starts at a point on the medial margin about a fourth of the length of the segment distal from its articulation and extends around to the distal lateral corner of the subquadrate segment.

The exopodite articulates with a wide emargination extending along the distal half of the lateral rim of the basis. The exopodite is well-developed, fairly long, and tapered from a wide base. It is 4-segmented. The armature consists of five well-developed setae, one inserted on each of the more proximal segments and two of the ultimate segment. All the setae of the mandible are plumose.

The protopodite of the maxillule (fig. 10,*e*) shows a considerable degree of coalescence, with no clear indication of the fundamental plan of its segmentation. The proximal endite is the usual flaring lobe set with a masticatory row of eight setae of varying dimensions. A second endite is represented by a narrowly triangular process extending along the apex of the proximal endite. The epipodite is a slight prominence bearing a well-developed principal seta accompanied by a rudimentary auxiliary seta. The plane of coalescence of the coxal portion of the protopodite with the basis is displaced to proceed almost longitudinally. The three subequal setae assignable to the basipodite are inserted in a row along a truncate margin which is the distal boundary of the protopodite. The result of alteration of orientation is that both endopodite and exopodite are directed laterally. The endopodite bears three setae. The exopodite has three setae well developed, with an articulated fine setule which is the obvious vestige of a fourth seta.

The maxilla (fig. 10,*f*) is pentamerous. The protopodite is a single segment bearing four endites. The proximal endite is armed with

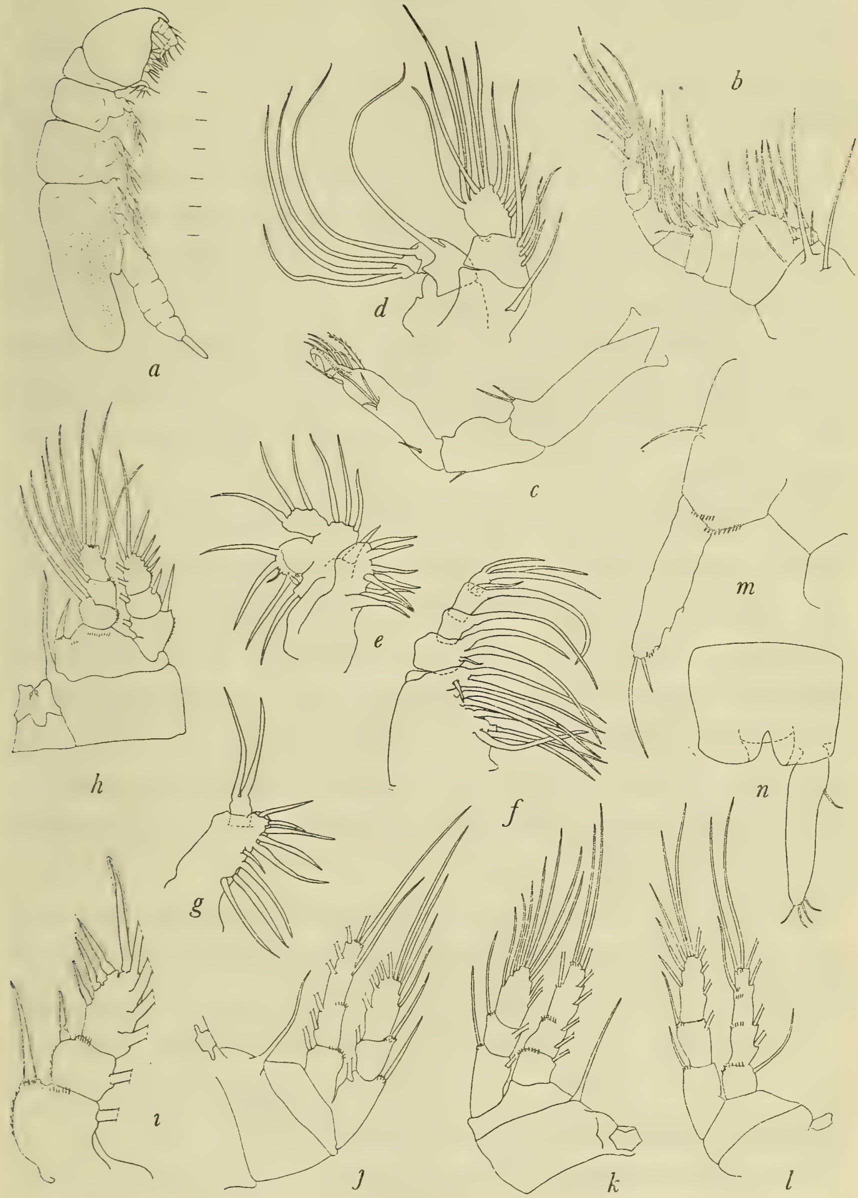

FIGURE 10.—*Doropygus profundus*, new species, female: *a*, habit, lateral view; *b*, antennule; *c*, antenna; *d*, palp of mandible; *e*, maxillule; *f*, maxilla; *g*, maxilliped; *h*, first leg; *i*, exopodite of first leg; *j*, second leg; *k*, third leg; *l*, fourth leg; *m*, fifth leg; *n*, caudal ramus. The scale, referring to *a*, represents 1.0 mm.

three setae, arranged in a characteristic row along a line at right angles to the axis of the appendage. The second endite has a single seta; the third endite bears a pair of equal setae; the fourth endite is the most produced and prominent and bears two subequal setae accompanied by a basal vestigial setule. The second segment bears two subequal setae and a vestigial setule. The distal seta is shorter and more rigid than its companion. It is the homologue of the heavy claw-process of other genera. The third and fourth segments bear a single seta each. The terminal segment has four setae. Three of these are apical. A reduced seta is borne on the surface of the segment just distal to the articulation.

The maxilliped (fig. 10,*g*) is bimerous. The gnathal margin bears a proximal quartet and a distal quintet of setae. The distal segment is articulated somewhat subapically and laterally on the basal segment. The armature of the distal segment consists of two long, subequal setae.

Swimming legs: In the first legs (fig. 10,*h*) the protopodites are extensive. The intercoxal plate is well developed. The coxa is ample, quadrate; it bears a medial seta which extends slightly beyond the midpoint of the distal segment of the exopodite. The distal margin of the basipodite is much indented to accommodate the articulations of the rami. The medial margin of the basipodite culminates in an expanded base supporting the usual articulated heavy spine. This spine reaches to a point at about a level with the proximal third of the second segment of the endopodite. The usual lateral seta of the basipodite is here either rudimentary or lacking. As an unusual feature of the outline of the basis there occurs a distal prolongation beyond the articulated spine to the level of articulation with the endopodite.

The major ornamentation of the trimerous exopodite (fig. 10,*i*) consists of six spines and six setae. The basal segment bears a lateral spine, nearly distally directed, and a medial seta. The second segment bears a lateral spine and medial seta. Of the four spines of the distal segment three are ranged along the lateral margin and one is apical. Of the setae, one is apical and three are inserted along the medial margin. The most basal and most distal spines are the longest and stoutest. The remaining four are subequal.

The trimerous endopodite is ornamented with a single medial seta on the basal segment, a single medial seta on the second segment, and six setae on the distal segment. The disposition of these setae is as a medial row of three, two apical and one near the midpoint of the lateral margin. The seta of the basal endopod segment is borne on a marked prolongation of the distolateral corner of the segment.

The 2-segmented protopodites of the second legs (fig. 10,*j*) are somewhat produced and extended laterally as well as distally in the sagittal plane. Most of the production is in the coxa. An intercoxal plate is present, but it is reduced and insignificant. The inner coxal seta is a highly developed one and reaches almost to the tip of the endopodite. The basis bears no readily detectable armature.

The exopodite is trimerous. All the elements of the armature exhibit the general qualities of setae, although those in positions usually occupied by spines on appendages homologous to this are somewhat differentiated from the remainder and, in the main, lack the ciliation usually occurring in setae. The basal segment bears a medial typical seta and a lateral seta which occupies the position of the usual spine. The second segment bears a lateral and a medial seta. The distal segment bears three lateral setae, two apical setae, and four medial setae.

The endopodite is bimerous with strong indication of fusion of two elements to form the distal segment. The proximal segment bears one medial seta. The armature of the distal segment is composed of five setae along the medial margin, two apical setae, and one seta set considerably subterminally on the lateral margin.

The protopodite of the third leg (fig. 10,*k*) very much resembles that in the second leg. The intercoxal plate is present, but somewhat more reduced than in the second legs. The medial coxal seta is long, extending to the level of the distal quarter of the length of the distal segment of the endopodite. The basis bears no armature.

The armature of the trimerous exopodite consists of setae and the elongate setalike modifications of the usual spines. The basal segment bears a spine on the medial distal corner and one on the lateral distal corner. The second segment is similarly ornamented. The third segment bears three setae on the lateral margin, two apical setae, and four setae along the medial margin.

The endopodite is bimerous and the distal segment is somewhat produced. The basal segment bears a single medial seta. The distal segment has a medial row of five setae, two apical setae, and one lateral seta.

The fourth legs (fig. 10,*l*) exhibit the prolongations laterally of the protopodites which occur in the two preceding pairs. The intercoxal plate is reduced to near vestigial proportions. The armature of the protopodite is either vestigial or lacking.

The exopodite is trimerous and the armature consists of slender setae. The basal segment bears a single lateral seta. Segment two has a lateral seta and a medial seta. The distal segment has three lateral setae, two apical setae, and four medial setae.

The endopodite is bimerous. The basal segment bears a single medial seta. The distal segment bears three medial setae, two apical setae, and two lateral setae.

Short rows of minute spinules ornament the bases of some of the setae and portions of the margins of the segments of all the four pairs of swimming legs.

Vestigial legs and caudal rami: The fifth legs (fig. 10,*m*) are bimerous. The proximal segments of the pair are connected by a medial sclerotized ridge suggestive of the intercoxal plates of legs 1 to 4. However, the homology of the protopodite here is not clear. The distal segment is elongate. The lateral margin is roughly linear, and the medial margin is characterized by a series of emarginations. Complications of the integumentary structure form characteristic spinulelike ornamentation of the emarginations. Two subequal setae are borne at the apex of the segment. There are a few short spinules set just subapically on the medial margin.

The length of each caudal ramus (fig. 10,*n*) is roughly 4½ times its greatest width. The margins are rather smooth and there is a gentle taper to the rounded apex. A lateral seta is set at about the proximal quarter of the length of the outer margin. There are four roughly equal apical setae. The lengths of the setae are about two-thirds the greatest width of the ramus.

Male: There is no outstanding feature in the sexual dimorphism of this species except the presence of the usual rudimentary sixth legs borne on the genital segment of the male.

REMARKS: This species comes from the greatest depth so far recorded for an ascidicolous copepod.

Doropygus schellenbergi, new species

FIGURE 11

TYPES: Holotypic female, USNM 92796 (type locality, off Georgia, in unidentified ascidian), and paratypes listed below.

SPECIMENS EXAMINED:

GEORGIA

From ascidian:

Off Georgia, lat. 32°03′ N., long. 79°49.5′ W., dredged in 14 fms., Feb. 13, 1940, U. S. Fish and Wildlife Service Vessel *Pelican*, Station 181–13, holotypic female and 10 female paratypes.

DESCRIPTION: Female (fig. 11,*a–m*): General features: This is a minute species of *Doropygus*. A notable feature is the distinct sclerotization, particularly in its extension to the urosome and caudal rami. The metasome (fig. 11,*a*) is much inflated with some tendency to obscuring of the segmentation. The head is produced anteriorly and ventrally in a stout projection, forming the usual rostrum.

Head appendages: The antennule (fig. 11,*b*) is of moderate length, much greater in diameter basally than at the tip. No segment is particularly elongate. There are nine segments, of which the proximal is longest and by far the most massive. The second segment and the third approach the first in length and mass. The proximal two segments are of fairly uniform thickness and are succeeded by the third to sixth, which are sharply graduated in diameter so that the appearance has a telescope effect tapering the appendage to the terminal trimerous unit of seventh to ninth segments, which are subequal in length and fairly equal in width. The setation is relatively profuse and exhibits no differentiation of particularly distinctive elements except that the second, fourth, and fifth segments bear long, fairly robust setae.

The trimerous antenna (fig. 11,*c*) is slender and elongate, with reduced ornamentation. The basal segment forms a complicated articulation with the head and the medial margin has a slight distal expansion. The length is about four times the width at the midpoint. The articulating ends of the second segment are of the same width as the basal segment and the length is twice this. The outline of the segment is modified by the production of the middle half of the medial margin as a semicircular protuberance. The terminal segment is half again as long as the second segment. The greatest width is at the distal eighth and from this the segment tapers proximally to a width at the articulation of half that of the articulating margin of the second segment. Apically the segment tapers sharply to the articulation of the relatively slender, curved terminal hook. A slender seta is inserted at the articulation of the hook. A second seta is inserted at the distal third of the outer margin.

The basal segment of the mandible is the expanded coxa produced medially into a masticatory process. The medial portion of this process is a flat dentate plate, heavily sclerotized. The remainder of the mandible consists of a basipodite and two rami (fig. 11,*d*). The ornamentation of the basis consists of a single, slight seta inserted somewhat distal to the midpoint of the medial margin. The endopodite is placed terminally on the elongate basis and is 2-segmented. Four setae are arranged in a close-spaced row on the distolateral portion of the medial margin of the proximal segment. The somewhat larger distal segment is ornamented with seven setae. Three are widely spaced along the medial margin, the remainder are close-set along the broadly truncate terminal margin. The exopodite is inserted considerably subterminally on the basis and is extremely long and somewhat slender. The four long, slender, subequal setae are crowded into a compact row across the distal fourth of the ramus,

with the bases so compacted as to offer the appearance of a terminal segment.

The maxillule (fig. 11,*e*) is distinctive. The basal portion is long and is expanded medially as the proximal endite. Eight masticatory setae are arranged along the medial margin of the endite. A single seta is inserted on the slight prominence representing the second endite. The epipodite is represented by a long, proximally directed seta. The basipodite is so directed that its anatomically medial setiferous margin is distal. Three long, subequal setae are inserted in an apical row. The endopodite is directed laterally and bears two widely spaced terminal setae. The exopodite bears three setae inserted along the broadly truncate distal margin.

The maxilla (fig. 11,*f*) is pentamerous, with all the segments exhibiting setiferous medial protuberances. The basal segment bears four projections upon which are inserted, respectively, three, one, two, and two setae. The second segment bears two almost equal setae. The third and fourth segments bear each a single seta. The fourth segment bears two medially inserted setae and a more reduced apical seta.

The maxilliped (fig. 11,*g*) is a flattened, subrectangular plate exhibiting marked suppression of segmentation. At the midpoint of the medial margin is borne a trio of setae inserted in a transverse row. Distally on this margin is an irregular row of five setae. Subapically on the distal lateral corner two long setae are inserted on a slight protuberance which represents the suppressed terminal segment.

Swimming legs: The first leg (fig. 11,*h*) is generalized in plan. The coxa bears a medial seta, and there is a well-developed intercoxal plate. The basipodite exhibits the characteristic oblique distal margin, the lateral edge very short. The medial margin is long, accommodating the marked distal prolongation which supports a stout, tapered, curved spine which reaches to the distal margin of the second segment of the exopodite. Each of the rami consists of three subequal segments.

The proximal segment of the exopodite bears a lateral spine and a medial seta. The second segment bears a lateral spine and a medial seta. The lateral margin of the distal segment bears three equal spines. There is a much longer apical spine, accompanied by a short, slender seta. The three medial setae are graduated in length proximally, so that the tip of the most basal one actually extends beyond that of the most distal. The spines of the two proximal segments are roughly equal in dimension with the three marginal spines of the distal segment.

The two proximal segments of the endopodite bear each a single medial seta. The six setae of the distal segment are arranged as three

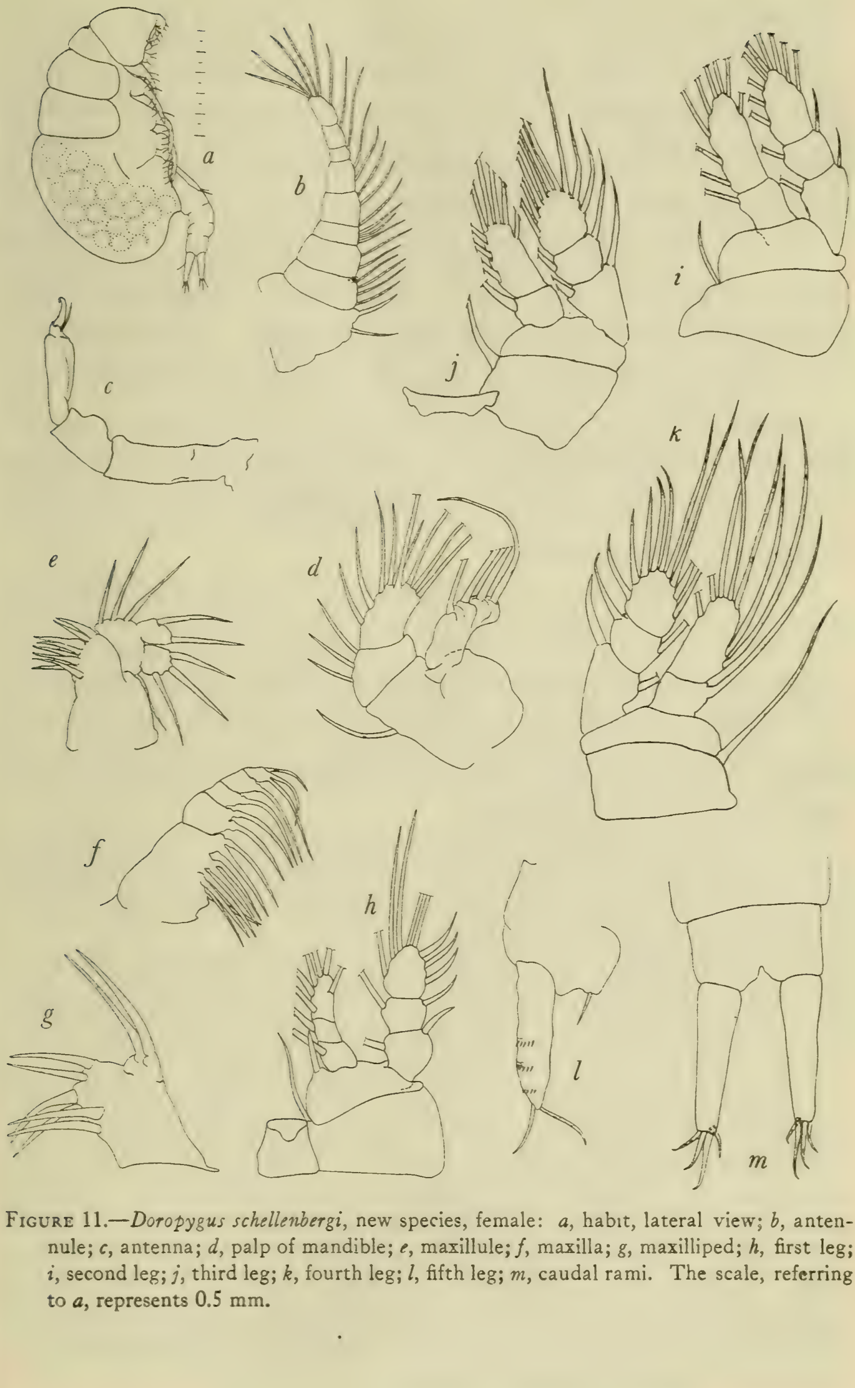

FIGURE 11.—*Doropygus schellenbergi*, new species, female: *a*, habit, lateral view; *b*, antennule; *c*, antenna; *d*, palp of mandible; *e*, maxillule; *f*, maxilla; *g*, maxilliped; *h*, first leg; *i*, second leg; *j*, third leg; *k*, fourth leg; *l*, fifth leg; *m*, caudal rami. The scale, referring to *a*, represents 0.5 mm.

along the medial margin, two apical, and one placed on an apically oriented emargination at about the midpoint of the lateral margin.

The second legs (fig. 11,*i*) consist each of a bimerous protopodite, the coxopodites yoked by a rudimentary intercoxal plate, and of a trimerous exopodite and bimerous endopodite. Each coxa bears a slender, relatively short seta at the distal medial corner. The very short lateral margin of the basis is set with a short, slender seta.

The two proximal segments of the exopodite bear each a lateral slender spine and a proximal seta. The terminal segment bears four spines and five setae, one of each apical, the remaining three spines disposed along the lateral margin, the setae medial. On each segment the portion of margin just proximal to the first spine is finely spinulose.

The basal segment of the endopodite has a single medial seta. The complement of eight setae of the terminal segment is arranged with four along the medial margin, two apical and one subterminal on the lateral edge, and one inserted at the distal fourth of the lateral margin. A pronounced constriction at the midpoint of this segment indicates its suppressed segmentation.

The third legs (fig. 11,*j*) are almost identical in proportion and ornamentation with the second legs. The formulae of spines and setae are the same in the two pairs. The spines of the exopodite are even longer and more slender and closely approach setiform dimensions.

The fourth legs (figs. 11,*k*) consist of bimerous protopodites, trimerous exopodites, and bimerous endopodites. The intercoxal plate is obsolete. Each coxa bears a slender, rather short medial seta. Each basis bears a slender lateral seta.

The two basal segments of the exopodite bear each a lateral spine and a medial seta. The terminal segment bears two lateral marginal spines, an apical spine and seta, and four medial setae. The spines are slender and markedly setiform.

The basal segment of the endopodite bears a single medial seta. The distal segment bears three setae on the medial margin, two apical setae, one subterminal laterally, and one inserted at the distal fourth of the lateral margin. The segment is constricted at the midpoint.

Vestigial legs and caudal rami: The bases of the bimerous fifth legs (fig. 11,*l*) are broad, subrectangular, and relatively massive. The length approaches the width in measure. Inserted at the lateral distal corner is a small seta. The terminal segment is articulated along the medial portion of the distal margin and its basal width is half that of this margin. The segment is slightly less than four times as long as wide. It tapers very slightly to the distal fourth, then much more markedly to the narrow apex. Two slender setae are apically inserted. Fine spinules arranged in four short rows along the medial margin furnish the remaining ornamentation.

The caudal rami (fig. 11,*m*) are notable for the rigid sclerotization of their lateral and medial margins. The lateral margin is linear, the medial so inclined as to furnish a marked taper throughout the ramus. The apical width is half the basal. The length is four times the basal width. Three graduated setae are compactly inserted across the apex. The medial of these is half again as large as that next to it and the lateral one is less than half of the size of the middle seta. The longest is over a third as long as the ramus. Inserted just proximal to the medial seta is a fourth, reduced seta. Inserted at the proximal third of the lateral margin is a small, rudimentary seta.

No male has yet been found.

Doropygus seclusus, new species

FIGURE 12

TYPES: Holotypic female USNM 92806 (type locality, Washington Sound, Washington, in *Chelyosoma productum* Stimpson); allotypic male, No. 92807, and paratypes listed below.

SPECIMENS EXAMINED:

WASHINGTON

From *C. productum:*

- East of Upright Channel, dredged in 25–35 fms., June 23, 1950, holotypic female, allotypic male, 29 female paratypes.
- Friday Harbor, July 1928, K. L. Hobbs, 4 specimens.
- Off Upright Head, Lopez Island, dredged in 15 fms., Aug. 2, 1949, 1 female.
- Garrison Bay, San Juan Island, June 30, 1950, P. Knight, 4 females.
- Roche Harbor, San Juan Island, growing on floats, July 6, 1950, 1 female.
- Garrison Bay, San Juan Island, in lowest intertidal, July 30, 1950, 4 females.

DESCRIPTION: Female (fig. 12,*a–m*): General features: This is a large species of *Doropygus* with a markedly inflated body (fig. 12,*a*). The integument is rather heavily sclerotized so that the segments are neatly delimited. The metasome includes the head, free somites of the first, second, and third swimming legs, and the expanded incubatory segment corresponding to the fourth swimming legs. The urosome is 6-segmented. It includes two thoracic somites, of which the more anterior is that of the fifth legs. The front of the head is midventrally produced as a well-developed rostrum.

Head appendages: The antennule (fig. 12,*b*) is 9-segmented. The two basal segments are inflated. There is a considerable diminution in measurement from the second segment to the third, succeeded by a sharp taper through the third through sixth segments. The terminal three segments taper gradually. The apical segment is much longer than wide. The basal segment, measured along its greatest length, is three times as long as the apical segment. The greatest width of the basal segment is seven times that of the apical segment. The setae

are short, somewhat rudimentary, with plumose ciliation almost entirely obsolete. They are concentrated along an outer setiferous margin. The basal segment has two long stout setae at the outer distal corner, these accompanied by one or two minor setae. The second segment bears the greatest number of setae, 10 or more. Third, fourth, and fifth segments bear a small number of setae. The sixth segment is distinctive for the very long and well-developed seta inserted at the distal outer corner and bears two or more minor setae as well. The seventh and eighth segments have few setae, one or two each. The terminal segment is ornamented with six or more setae which tend in their arrangement to form an apical radiating tuft.

The antenna (fig. 12,*c*) is trimerous with the basal segment the longest. The posture of the limb is in a characteristic right-angled flexure. At the distal corner of the basal segment, internal to the flexure, are inserted two minute but distinct setules. The length of the second segment but slightly exceeds its greatest width. The segment is slightly but not markedly narrower than the first. The outer margin is longer than the medial, and the central two-thirds of the medial margin is occupied by a prominent hemispherical bulge. The terminal segment is the narrowest, about 2½ times as long as wide, and its greatest width is about two-thirds that of the second segment. Inserted on the distal end in a complicated articulation is a long, curved, stout, tapered hook. Three much-reduced setae are set on the distal end of the segment close to the articulation of the hook. Three setae form a compact cluster appressed on the surface of the segment at about its midpoint.

The mandible consists of a 2-segmented protopodite, a bimerous endopodite, and a tetramerous exopodite. The coxopodite is extended medially as the usual masticatory plate featured by a serrate inner margin. The basipodite (fig. 12,*d*) is a much-elongated segment. Near its distal medial corner is inserted a single seta. The medial portion of the terminal margin of the segment is arranged to form a wide articulation with the endopodite. The proximal segment of the endopod is a fourth again wider than the distal segment and about equal in length. Along the distal medial margin of the proximal segment is inserted a row of four setae. These are graduated markedly from a small proximal seta to an elongate distal seta. Forming a row around most of the medial margin and the whole of the truncate apical border of the terminal segment are 10 graduated setae. Seven of these form a close-spaced row. Three have their bases closely associated on a slight distolateral prominence of the segment.

The exopodite is conspicuous, long and tapered from its insertion on the basipodite to a narrow apex of about half the width of the base. The segmentation is obsolete. The four setae are arranged with three

regularly spaced along the distal half of the medial margin and one apical.

The maxillule (fig. 12,*e*) is characterized by a marked tendency to obliteration of obvious segmentation. The protopodite is obscurely 2-segmented. The basal portion supports two endites and a reduced epipodite. The proximal endite is expanded and conspicuous. Distally along its medial margin is inserted a row of nine setae, predominantly stout and sharply tapered, although two are slender. Just distal to this principal endite is a small projection terminating in a setiform elongation which is considered to represent a second endite. The epipodite is almost obsolete, represented by a long tapered seta accompanied by a minute accessory setule.

The terminal mass of the protopodite, equivalent to the basipodite, bears a distally directed row of three setae. Almost entirely laterally oriented on the apex of the protopodite are the two reduced rami, each bearing three setae. The setae of the endopodite are inserted respectively apically and upon two emarginations of the medial border. The setae of the exopodite radiate fan-wise from closely set bases along the truncate distal margin.

The maxilla (fig. 12,*f*) is pentamerous. The principal mass of the appendage consists of the basal segment which bears four setiferous prominences representing endites. The basal endite bears three setae. The second endite is represented by a single seta inserted on a very slight prominence. The third endite bears two equal setae. The fourth endite is the longest. It forms a fairly well demarcated mass bearing three members. Two of these are well developed, of about equal proportions, inserted apically. Just proximal to these is set a reduced setule.

The second segment is much wider than long. Distally this segment extends in a medial prolongation which constitutes a rather slender hook, about three-fourths as long as the principal setae of the maxilla. Inserted at the base of the hook are one well-developed long seta and an accessory reduced setule.

The two next distal segments are subequal in proportion. Inserted prominently at the distal medial corner of each of these segments is a single long seta. The reduced terminal segment bears four setae. Three of these are subequal and their bases are close-set in an apical insertion. The fourth is the smallest and is inserted on the surface of the segment toward the basal articulation. The terminal complex of three distal segments is relatively short, less than one-third again as long as the second segment.

The bimerous maxilliped (fig. 12,*g*) is relatively stocky. The medial margin bears nine setae arranged in two groups. The proximal set of setae consists of a marginal trio and a single seta displaced far

FIGURE 12.—*Doropygus seclusus*, new species. *a–m*, Female: *a*, habit, lateral view; *b*, antennule; *c*, antenna; *d*, palp of mandible; *e*, maxillule; *f*, maxilla; *g*, maxilliped; *h*, first leg; *i*, second leg; *j*, third leg; *k*, fourth leg; *l*, fifth leg; *m*, caudal ramus. *n*, Male: fourth leg. The scale, referring to *a*, represents 1.0 mm.

laterally onto the surface of the segment. The distal five setae are close-set around the curved distal medial margin. Articulated subapically and far laterally is the much-reduced distal segment. It provides insertion for two long, approximately equally developed setae. The medial margin of the terminal segment bears a row of fine, long cilia.

Swimming legs: The protopodites of the first legs (fig. 12,*h*) are conspicuously bimerous; the rami are trimerous. The coxopodites, yoked by a triangular, apically bilobed, intercoxal plate, are of rectangular outline. At the medial distal corner of each coxa is inserted a long tapering seta, the tip of which reaches just beyond the distal border of the second segment of the endopodite. The basipodite has a relatively long medial margin and a long diagonal articulation with the coxopodite. A reduced seta is inserted near the lateral margin. At the medial distal corner of the basis is articulated a well-developed tapering spine which reaches to the midpoint of the second segment of the endopodite. A curved row of spinules constitutes an ornamentation of the basis near the articulation of the endopodite. There are also a few spinules inserted near the base of the medial spine.

The segments of the exopodite are subequal. The basal is the widest, and each of the succeeding segments is diminished somewhat in width. Each of the two proximal segments bears a stout lateral spine and an elongate medial seta. Inserted on the terminal segment are three spines along the lateral margin, an apical outer spine and inner seta, and three setae along the medial border. The lateral spines are subequal in length and of about equal thickness. The apical spine is about one-fourth again longer than any of these. The proximal spine of the third segment is perhaps the shortest. All the spines have partial or extensive transparent serrated marginal flanges. The lateral margin of each segment proximal to its spine or spines is markedly spinulose, and other fine spinules form ornamentation laterally on the two proximal segments.

The two proximal segments of the endopodite bear each a medial seta. The terminal segment bears three medial marginal setae, two apical setae, and a seta inserted in an emargination at about the midpoint of the lateral margin. The medial and apical setae form a regular row and exhibit a graduated distal diminution in thickness.

The second legs (fig. 12,*i*) show the initial stages of tendencies progressively developed in the succeeding two pairs of legs. The articulation of coxopodite and basipodite is somewhat diagonal so that the lateral margin of the coxa is longer than the medial margin. There is a uniting intercoxal plate, but the distal extent of this is only short of the midpoint of the medial margin of the coxa and the plate is weakly sclerotized. There is inserted on the medial distal corner

of the coxa a well-developed seta which extends to a point at about the distal fourth of the basal segment of the endopodite.

The exopodite is trimerous. Its armature consists of the usual lateral spines and medial setae. However, the distal elements in the usual position of spines tend to setiform construction. There is a short slender lateral spine and a well-developed medial seta borne on each of the two proximal segments. On the distal segment there are three laterally inserted spines and an apical elongate spine approximating a seta in proportions. There is a medial apical seta. Inserted along the medial border are four well-developed setae. There is a fairly profuse spinose ornamentation of all the segments.

The endopodite is bimerous, with the elongate distal section preserving traces of a fundamental segmentation. The basal segment bears one medial seta. The elongate distal segment tapers only slightly apically. It bears five marginal medial setae, two apical setae, and a single seta inserted in an emargination removed proximally about a third the length of the segment from the apex. A short row of spinules curves across the face of the segment at the level of the second medial seta. There are also spinules at the bases of the lateral and apical setae and a row of spinules on the lateral distal border of the basal segment.

The line of articulation of the coxopodite and basipodite of the third legs (fig. 12,*j*) is markedly diagonal. The lateral margin of the coxa is two-thirds its width. The medial proximal corners of the coxopodites are yoked by a rudimentary intercoxal plate, the length of which approximates only one-half its width. At the distal medial corner of the coxa is borne a seta which extends to the level of the insertion of the second seta of the second segment of the endopodite.

The proximal two segments of the exopodite bear each a short slender lateral spine and a normal medial seta. The terminal segment bears three lateral spines, graduated in length, two apical setae, and four medial setae. The lateral apical seta is the shorter and is obviously somewhat spiniform.

The bimerous endopodite extends to about the midpoint of the terminal segment of the exopodite. The basal segment bears a single medial seta. The distal segment, elongate, somewhat tapered, and with vague indications of fundamental subdivision, bears five medial setae, two apical setae, and one lateral seta. Further ornamentation of the rami is provided by short rows of fine spinules.

In the protopodite of the fourth leg (fig. 12,*k*) the line of articulation of the coxopodite and basipodite is slightly diagonal so that the outer margin of the coxopodite is greater than the length of the medial margin. The coxopodites are yoked by an intercoxal plate.

This is of nearly normal proportions and the outer margins are coextensive with the medial margins of the coxa. Inserted on the distal medial corner of the coxopodite is a slender seta which extends to about the midpoint of the proximal segment of the endopodite. Near the short lateral margin of the basipodite is inserted a much-reduced setule.

The basal segment of the trimerous exopodite is elongate. It bears a short lateral spine and a very short medial seta which scarcely exceeds the spine in length. The second segment bears a lateral spine and a medial seta. The terminal segment bears three lateral spines, slightly tending toward setiform aspect, an apical spine which closely approximates setiform proportions, an apical seta, and four setae disposed along the medial border.

The endopodite is bimerous, but with the elongate second segment preserving traces of the fundamental subdivision into two podomeres. The basal segment bears a very short, reduced medial seta. The distal segment bears four setae arranged along the medial margin, two apical setae, and a lateral seta inserted in an emargination of the border of the segment opposite the insertion of the third medial seta. The lateral seta and the two more proximal setae of the distal segment are considerably reduced. A row of fine spinules ornaments the distal border of the basal segment of the endopodite and a second row curves over the surface of the distal segment at the level of the second seta. A few spinules are set at the insertions of the lateral setae of the endopodite and of the spines of the exopodite.

Vestigial legs and caudal rami: The bimerous fifth legs (fig. 12,*l*) are elongate, with expanded bases. The basal segment is over twice as wide as long and lacks ornamentation. The distal segment is five times as long as its basal width and only about a fifth of the width of the basal segment. The margins are roughly parallel, with a very slight distal taper to the somewhat narrowed apex. The armature consists of two apically inserted subequal elements, the more medial somewhat spiniform; the lateral a reduced seta. Along the medial side there are five projections interrupting the margins. These constitute elaborations of the integument related to rows of fine spinules. Each row of spinules extends a considerable distance laterally over the surface of the segment. The spinules are fine-textured, closely appressed to the segment, and not readily obvious. A sixth row is inserted at the articulation of the terminal spine.

The caudal rami (fig. 12,*m*) are relatively long, their length about four times the greatest width. The margins are nearly parallel for about half the length; distally the ramus tapers gradually and curves slightly outward, terminating in a curved apex narrowed to about one-third of the basal width. Four minute setules are inserted in a

terminal row on the apex. A setule is inserted on the lateral margin at about the proximal fourth of its length. The length of the setules is about a sixth of the apical width of the ramus.

Male (fig. 12,*n*): The sexual dimorphism in appendages of this species is expressed only in minor variations. The antennule of the male conforms very well to that in the female, except for a slight tendency to coalescence of the distal three segments, and the development of a somewhat enlarged hook-seta on the basal segment. The ornamentation of the swimming legs tends to much more spiniform aspect than in the female. In the first legs (fig. 12,*n*) the most distal setae of the endopodite are short, stiff, and sharply tapered, approaching the consistency of spines. On the posterior legs this tendency is still more marked, as was illustrated in the case of *D. mohri*. The spermatophores intrude considerably into the segment of the fifth legs. The sixth legs are bisetiferous prominences.

Remarks: The mature female of this *Doropygus* has almost always been found solitarily in the branchial cavity of the host. This species shows wide tolerance to the site of habitation of the host. Specimens have been found in ascidians collected intertidally, on floats and subtidally, by dredging.

The color of this species is striking, especially in contrast to the dull gray pallor of the host. The body varies from pink to pale orange, and the eggs are a dark red-purple.

Species Incerta Sedis

Doropygus cylindriformis Schellenberg

Doropygus cylindriformis Schellenberg, 1922, pp. 240–241, figs. 21, 22 (type locality, Gulf of Suez, in *Ascidia canelata* (Sav. Ok.)).—Gurney, 1927, p. 482.—Sewell, 1949, pp. 169, 179.

Distribution: Gulf of Suez.

Host: *Ascidia canelata* (Sav. Ok.).

Indeterminable Species

Doropygus acutus Hesse

Doropygus acutus Hesse, 1866, pp. 64–65 (type locality, coast of France).—Gerstaecker, 1870–1871, pp. 775, 801.

Distribution: Coast of France.

Doropygus albidus Hesse

Doropygus albidus Hesse, 1866, p. 61 (type locality, coast of France, in *Ascidia intestinalis*).—Gerstaecker, 1870–1871, pp. 776, 801.

Distribution: Coast of France.

Host: *Ascidia intestinalis*.

Doropygus arcticus Aurivillius

Doropygus arcticus Aurivillius, 1885a, pp. 233-236, pl. 8, figs. 1–11 (type locality, off Pitlekaj, Siberia, from *Chelyosoma macleayanum* Sow. et Brod.); 1885b, p. 282.—Hartmeyer, 1911, p. 1734.—Wilson, 1920, p. 14.—Schellenberg, 1922, p. 240.—Lang, 1948, p. 7.

Distribution: Arctic coast of Siberia.

Host: *Chelyosoma macleayanum* Sow. et Brod.

Doropygus callipygus Hesse

Doropygus callipygus Hesse, 1866, p. 58 (type locality, coast of France, in *Ascidia venosa*.—Gerstaecker, 1870–1871, pp. 776, 801.

Distribution: Coast of France.

Host: *Ascidia venose.*

Doropygus coccineus Hesse

Doropygus coccineus Hesse, 1866, pp. 67–68 (type locality, coast of France).—Gerstaecker, 1870–1871, pp. 775, 801.

Distribution: Coast of France.

Doropygus conicus Hesse

Doropygus conicus Hesse, 1866, pp. 57–58 (type locality, coast of France, in *Cynthia microcosmus*).—Gerstaecker, 1870–1871, pp. 777, 801.

Distribution: Coast of France.

Host: *Cynthia microcosmus.*

Doropygus cristatus Hesse

Doropygus cristatus Hesse, 1871, pp. 21–23, pl. 2, fig. 18 (type locality, coast of France, in *Ascidia canina*).

Distribution: Coast of France.

Host: *Ascidia canina.*

Doropygus curculio Hesse

Doropygus curculio Hesse, 1866, pp. 54–55 (type locality, coast of France).—Gerstaecker, 1870–8171, pp. 775, 801.

Distribution: Coast of France.

Doropygus deflexus Hesse

Doropygus deflexus Hesse, 1866, pp. 58–59 (type locality, coast of France).—Gerstaecker, 1870–1871, pp. 778, 801.

Distribution: Coast of France.

Doropygus gibbosus Hesse

Doropygus gibbosus Hesse, 1866, pp. 62–63 (type locality, coast of France, in *Ascidia intestinalis*).—Gerstaecker, 1870–1871, pp. 776, 801.

Distribution: Coast of France.

Host: *Ascidia intestinalis.*

Doropygus globosipherus Hesse

Doropygus globosipherus Hesse, 1869, pp. 307–308 (type locality, coast of France).—Gerstaecker, 1870–1871, pp. 775, 801.—Della Valle, 1883, p. 245.

DISTRIBUTION: Coast of France.

Doropygus macroon Hesse

Doropygus macroon Hesse, 1866, pp. 66–67 (type locality, coast of France).—Gerstaecker, 1870–1871, pp. 775, 801.

DISTRIBUTION: Coast of France.

Doropygus molgulensis Pearse

Doropygus molgulensis Pearse, 1952, pp. 188–189, fig. 1 (type locality, Alligator Harbor, Fla., in *Molgula occidentalis* Traustedt).

DISTRIBUTION: Florida.
HOST: *Molgula occidentalis* Traustedt.

Doropygus oblongus Hesse

Doropygus oblongus Hesse, 1866, p. 59 (type locality, coast of France, in *Polyclinum stellatum*).—Gerstaecker, 1870–1871, pp. 774, 801.—Della Valle, 1883, p. 245.

DISTRIBUTION: Coast of France.
HOST: *Polyclinum stellatum.*

Doropygus ponticus Grebnitskiĭ

Doropygus ponticus Grebnitskiĭ, 1873–1874, pp. 218, 246 (type locality, Black Sea).

DISTRIBUTION: Black Sea.

Doropygus postremoglobosus Hesse

Doropygus postremoglobosus Hesse, 1871, pp. 23–24 (type locality, coast of France, in *Ascidia canina*).

DISTRIBUTION: Coast of France.
HOST: *Ascidia canina.*

Doropygus propinquus Hesse

Doropygus propinquus Hesse, 1866, pp. 56–57 (type locality, coast of France).—Gerstaecker, 1870–1871, pp. 775, 801.

DISTRIBUTION: Coast of France.

Doropygus reflexus Hesse

Doropygus reflexus Hesse, 1866, pp. 65–66 (type locality, coast of France, in *Ascidia venosa*).—Gerstaecker, 1870–1871, pp. 776, 801.

DISTRIBUTION: Coast of France.
HOST: *Ascidia venosa.*

Doropygus rotundus Hesse

Doropygus rotundus Hesse, 1866, p. 60 (type locality, coast of France, in *Ascidia aspesa* [sic]).—Gerstaecker, 1870–1871, pp. 775, 801.

Distribution: Coast of France.
Host: *Ascidia aspesa* [sic].

Doropygus rufescens Hesse

Doropygus refescens Hesse, 1866, p. 67 (type locality, coast of France).—Gerstaecker, 1870–1871, pp. 774, 801.—Della Valle, 1883, p. 245.

Distribution: Coast of France.

Doropygus sphaerasipherus Hesse

Doropygus sphaerasipherus Hesse, 1869, pp. 305–307 (type locality, coast of France).—Gerstaecker, 1870–1871, pp. 775, 801.—Della Valle, 1883, p. 245.

Distribution: Coast of France.

Doropygus tumefactus Hesse

Doropygus tumefactus Hesse, 1866, p. 63 (type locality, coast of France).—Gerstaecker, 1870–1871, pp. 775, 801.

Distribution: Coast of France.

Doropygus verrucosus Hesse

Doropygus verrucosus Hesse, 1866, pp. 60–61 (type locality, coast of France, in *Ascidia venosa*).—Gerstaecker, 1870–1871, pp. 776, 801.

Distribution: Coast of France.
Host: *Ascidia venosa.*

Doropygus viridis Hesse

Doropygus viridis Hesse, 1866, p. 61 (type locality, coast of France, in *Cynthia microcosmus*).—Gerstaecker, 1870–1871, pp. 777, 801.

Distribution: Coast of France.
Host: *Cynthia microcosmus.*

Doropygus sp. Herdman

Doropygus n. sp. Herdman, 1889, p. 254.

Distribution: Off Liverpool; Loch Fyne.
Hosts: *Polycarpa pomaria* Savigny, *Styela rustica.*

Nomina nuda

Doropygus coeruleus Sewell

Doropygus coeruleus Sewell, 1949, p. 157.

Doropygus gibbosa T. Scott

Doropygus gibbosa T. Scott, 1901, p. 351.—Sewell, 1949, p. 188

Genus *Doropygella* G. Sars, emended

Doropygus Thorell, 1859a, pp. 43–46 (part).—Aurivillius, 1882b, p. 49.—Giesbrecht, 1882a, pp. 324–326 (part).—Canu, 1892, pp. 193–194 (part).—Schellenberg, 1922, pp. 238–241 (part).

Doropygella G. Sars, 1921, p. 49 (type species, by monotypy, *Doropygus thorelli* Aurivillius, 1882b).—Wilson, 1932, p. 599.

Doropygelia Wilson, 1936, p. 376.

The differentiation of this genus from *Doropygus* has already been discussed under the latter. The outstanding features of the generic diagnosis of *Doropygella* are as follows. The urosome, including segment of fifth legs, is 5-segmented. The exopodite of the maxillule bears four setae; the endopodite bears six or more, and may preserve indications of a bimerous condition. The maxilliped, basically trimerous with unornamented second segment, may be reduced to bimerous with terminal segment bearing three setae or the segmentation may be obsolete with two terminal setae present. The remaining appendages are specifically variable.

Key to the species of *Doropygella*, based upon females

1*a*. Caudal rami very long, coiled at the tip . . . . **porcicauda** (p. 590)
1*b*. Caudal rami not terminally coiled 2
2*a*. Armature of lateral margins of third and fourth exopodites long setae **normani** (p. 590)
2*b*. Armature of lateral margins of third and fourth exopodites spines 3
3*a*. Caudal rami no more than 2 or 3 times as long as wide . . **thorelli** (p. 591)
3*b*. Caudal rami 5 or more times longer than wide . . . . . . **psyllus** (p. 591)

Species not known from North America

Doropygella normani (Brady), new combination

Doropygus normani Brady, 1878, pp. 136–138, pl. 32, figs. 1–14 (type locality, Ireland).—Richiardi, 1880, p. 147.—Giesbrecht, 1882a, p. 324.—Carus, 1885, p. 342.—Gourret, 1888, p. 1.—Herdman, 1889, p. 254.—T. Scott, 1891, p. 301; 1902, p. 455; 1906, p. 363; 1907, p. 364.—Thompson and Scott, 1903, p. 255.—Norman, 1905, p. 36.—Pesta, 1909, p. 259.—Schellenberg, 1922, p. 241.—Sewell, 1949, pp. 169, 176, 177, 182.

Distribution: Mediterranean and British Isles; Ceylon.

Hosts: ? *Ascidia virginea*, *Cynthia papillosa* L., *Cynthia* sp., *Styela rustica*.

Doropygella porcicauda (Brady), new combination

Doropygus porcicauda, Brady, 1878, pp. 138–140, pl. 27, figs. 1–9, pl. 33, figs. 14–16 (type locality, British Isles, in *Ascidia parallelogramma*).—Giesbrecht, 1882a, p. 324.—Herdman, 1889, p. 249.—Thompson, 1889, pp. 185–186; 1893, p. 190, pl. 18, fig. 1.—T. Scott, 1888, p. 239; 1897, p. 148; 1900, p. 386; 1901, p. 351; 1906, p. 363; 1907, p. 364.—Norman and Brady, 1909, p. 401.—Pesta, 1909, p. 259.—G. Sars, 1921, pp. 45–46, pl. 22.—Schellenberg, 1922, pp. 241, 264.—Gray, 1933, pp. 520–521.—Gurney, 1933, p. 304.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 119.—Sewell, 1949, p. 188.

Distribution: British Isles, Norway.

Hosts: *Ascidia parallelogramma, A. plebeia* Alder.

Doropygella psyllus (Thorell), new combination

Doropygus psyllus Thorell, 1859a, pp. 49–50, pl. 7, fig. 9 (type locality, coast of Sweden, in *Ascidia aspersa* Müller); 1859b, pp. 339, 343; 1860, pp. 118, 123.—Hesse, 1866, pp. 54, 64.—Gerstaecker, 1870–1871, pp. 775, 801.—Kerschner, 1879, pp. 185–186.—Aurivillius, 1882a, pp. 54–55; 1882b, p. 112; 1883, pp. 24–25, 108.—Giesbrecht, 1882a, p. 324.—Carus, 1885, p. 342.—Gourret, 1888, p. 1.—Canu, 1891, p. 472; 1892, pp. 194–195, pl. 8, figs. 1–11.—Graeffe, 1902, p. 39.—T. Scott, 1907, pp. 364–365.—Pesta, 1909, p. 259.—Hartmeyer, 1911, p. 1735.—G. Sars, 1921, pp. 44–45, pl. 21.—Schellenberg, 1922, pp. 241, 265.—Brian, 1924, p. 7.—Harant, 1931, p. 370.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 119.—Lang, 1948, p. 2—Sewell, 1949, pp. 182, 188, 191.

Distribution: Mediterranean to Sweden and Norway.

Hosts: *Ascidia aspersa* Müeller, *A. fumigata, Phallusia patula, P. virginea.*

North American Species

Doropygella thorelli (Aurivillius)

Doropygus thorelli Aurivillius, 1882b, pp. 49–60, 112, pl. 13, fig. 10, pl. 14, figs. 1–14 (type locality, Sweden, in *Phallusia mentula*); 1883, pp. 45–56, 108, pl. 4, fig. 10, pl. 5, figs. 1–14.—Schellenberg, 1922, pp. 240, 265.

Doropygella thorelli G. Sars, 1921, pp. 49–50, pl. 24.—Hansen, 1923, p. 23.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 120, fig. 70.—Stephensen, 1929, p. 7; 1940, pp. 2–3, 18, 20.—Sewell, 1949, p. 191.

Doropygella thorellii Wilson, 1936, p. 368.

Doropygelia thorellii Wilson, 1936, p. 376.

Distribution: Norway and Sweden, Faröes, Iceland, Greenland, Davis Strait, Foxe Channel.

Hosts: *Ascidia obliqua, Phallusia mentula.*

Remarks: No specimens were available for the present study. The species has been thoroughly illustrated by G. Sars (1921, pl. 24).

Genus *Doropygopsis* G. Sars

Doropygus Aurivillius, 1882a, pp. 48–54 (part).—Schellenberg, 1922, pp. 238–241 (part).

Doropygopsis G. Sars, 1921, pp. 46–47 (type species, by monotypy, *Doropygus longicauda* Aurivillius, 1882).—Wilson, 1932, p. 598.

The basis of subdivision of this genus from the original concept of *Doropygus* is discussed under the latter. The principal features involved in the characterization of *Doropygopsis* are as follows.

The urosome is pentamerous, including the thoracic segment of the fifth legs and also a second, genital somite composed of both thoracic

and abdominal elements. The ornamentation of the caudal rami is fairly well developed, consisting of relatively normal short setae.

The antennule is 9-segmented. The antenna is trimerous with setation relatively unreduced. The maxillule presents the distinctive feature in the endopodite of presence of seven to nine setae. The exopodite bears the usual four setae. The maxilliped is trimerous with all segments setiferous.

The remaining appendages are more or less generalized in structure, conforming to the least specialized condition found in either *Notodelphys* or *Doropygus*.

Key to the species of *Doropygopsis*, based upon females

1*a*. Endopodite of maxillule with 7 setae . . . . **longicauda** (p. 592)
1*b*. Endopodite of maxillule with 9 setae . . . . . . **novemsetiferus** (p. 592)

Species not known from North America

Doropygopsis novemsetiferus **(Schellenberg), new combination**

Doropygus novemsetiferus Schellenberg 1922, p. 244 (type locality, Gulf of Suez, in *Styela canopus* Sav. and *Pyura gangelion* (Sav.).—Gurney, 1927, p. 480.—Sewell, 1949, pp. 169, 179.

Distribution: Gulf of Suez.

Hosts: *Styela canopus* Sav., *Pyura gangelion* (Sav.).

North American Species

Doropygopsis longicauda **(Aurivillius)**

Doropygus longicauda Aurivillius, 1882a, pp. 48–54, pl. 7, figs. 1–12 (type locality, Bohuslan, Sweden, in *Phallusia obliqua*); 1882b, pp. 60–61, pl. 13, fig. 11; 1883, pp. 18–24, 56–57, 108, pl. 3, figs. 1–12, pl. 4, fig. 11; 1886, pp. 43–44, pl. 1, figs. 1–6.—Schellenberg, 1922, pp. 240, 264.

Doropygopsis longicauda G. Sars, 1921, pp. 47–49, pl. 23.—Hansen, 1923, pp. 22–23.—Stephensen, 1932, p. 3; 1940, pp. 2, 18, 20.—Blake, 1933, p. 226.—Pesta, 1934, p. 8.—? Wilson, 1935a, p. 779.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 119, fig. 69.—Lang, 1948, p. 2.—Sewell, 1949, pp. 161, 191–194.

Distribution: Sweden and Norway, Spitzbergen, Kara Sea, Faröes, Iceland, Greenland, Davis Strait, Maine, ? California.

Hosts: *Phallusia obliqua*, *P. mentula*, *Ascidia callosa*, *A. prunum*, *Boltenia echinata*, ?*Eugyra* sp.

Specimens examined:

Canada

From *Ascidia* sp.:

Off Grand Manan Island, New Brunswick, dredged in 97–110 fms., 1872, U. S. Fish Comm. Station 5028, 1 female.

Near entrance to Goose Bay, Lake Melville, Labrador, dredged 17–19 fms., Aug. 26, 1951, D. C. Nutt, 3 females.

From *Ascidia prunum* Müller:

Lake Melville, Labrador, dredged, July–August 1950, D. C. Nutt, 1 female.

From unidentified ascidians:

Off Labrador, lat. 53°22.3′ N., long. 55°56.7′ W., dredged in 35 fms., July 12, 1949, D. C. Nutt, 3 females.

Soak Point, Hebron Fjord, Labrador, dredged in 13 fms., Aug. 31, 1949, D. C. Nutt, 3 females, 4 males.

Off Labrador, 53°52′ N., long. 59°19′ W., dredged in 30–35 fms., July 11, 1950, D. C. Nutt, 5 specimens.

WASHINGTON

From *Ascidia callosa* Stimpson:

Off Dinner Island, San Juan Island, dredged in 30 fms., Aug. 10, 1949, R. L. Fernald, 3 females, 1 male.

East of Upright Channel, dredged, June 23, 1950, 3 females.

From *Ascidia paratropa* (Huntsman):

Off Upright Head, Lopez Island, dredged in 15 fms., July 27, 1949, R. L. Fernald, 1 female.

Upright Channel, dredged, July 19, 1950, 2 females.

From *Halocynthia igaboja* (Oka):

Off Upright Head, Lopez Island, dredged, June 23, 1950, 1 female.

DESCRIPTION: Female: General features: Thorough illustration of this species has been provided by G. Sars (1921, pl. 23). The body is compressed, the metasome modified by the greatly expanded incubatorium. The head includes the segment of the maxillipeds and is characterized by wide-flaring lateral epimeral expansion. The segment of the first swimming legs is free, but seemingly lacks epimera. The segments of the second and third legs are much larger in size than the first segment and present well-developed, closely appressed epimeral plates. The fourth segment is the much-inflated brood sack. The major body articulation is between the segments of the fourth and fifth legs, since the latter segment does not conspicuously participate in the structure of the brood sack. The urosome is 5-segmented. The second segment is apparently a "genital somite" formed by coalescence of the last thoracic segment and first abdominal somite. There are three free abdominal segments, the last supporting the well-developed caudal rami.

A conspicuous rostrum is produced ventrally from the anterior tip of the head. It is bluntly pointed and relatively flattened.

Head appendages: The antennule is 9-segmented. The two basal segments are much expanded and so articulated on the head and with each other as to provide a nearly right-angled flexure. The third segment is much narrower than the second. The terminal six segments are graduated in a fairly regular, slight taper. The terminal segment is about an eighth as thick as the first segment and two-thirds as thick as the third segment. Most of the distal segments are slightly longer than wide. The sixth segment is twice as long as wide.

The seventh segment is roughly subquadrate. The terminal segment is twice as long as wide. Several segments are distinctive for the possession of one or more very long, basally stout setae. Two of these are inserted on each of the first two segments. Segments five and six bear one each. In addition, each segment bears a number of shorter, slender setae. The approximate count of setae by segments is: 1–3; 2–10 plus; 3–3; 4–3; 5–4; 6–3; 7–1; 8–2; 9–6. The larger setae are plumose and of fairly stiff consistency.

The trimerous antenna presents no indication of the fusion of the two more proximal segments of the antenna of the type found in *Notodelphys*. A long plumose seta is inserted terminally on the basal segment. The basal segment is twice as long as its greatest width. The second segment is 1½ times as long as wide, and two-thirds the length of the basal segment. The distal segment is slightly constricted basally and is the longest segment of the appendage. Its length is nearly four times its greatest width. Terminally there is articulated a stout, tapered, curved claw. Several setae, of varying lengths, are inserted apically, close to the base of the claw. At about the distal fourth of the segment there is inserted a compact row of three graduated setae which lie closely appressed to the surface of the segment. Just proximal to these is set a short marginal seta.

The mandible differs from that of *Notodelphys*. The masticatory plate of the coxa is ornamented along the medial edge by four principal tooth-like projections, a saw-edge of fine, close-spaced denticles, and two fine, setalike members. The basipodite is widely expanded. At the distal fourth of the medial margin is inserted one well-developed seta. The endopodite is bimerous. The subquadrate basal segment bears four setae, arranged as a row around the distal medial corner. The margins of the terminal segment are parallel, the length is about 1½ times the width, and the segment is about three-fourths the greatest width of the basal segment. Nine setae form a close-set row along the distal three-fourths of the medial margin and across the terminal border. The exopodite is a broad, flat plate with the segmentation obsolete. Five very long subequal setae are disposed along the distal expanse of the ramus.

The protopodite of the maxillule is elongate and rather narrow. The segmentation is strongly indicated. A small lateral protuberance, doubtless representing the epipodite, furnishes insertion for a long, stout, proximally directed seta and a short accessory setule. Medially there are two projections, probably representing endites. The proximal endite is a greatly developed, flaring prominence bearing a row of nine masticatory setae close-set along the medial margin. Just distal to this endite is the slight prominence of the second, produced distally as an elongate, tapering, setiform structure. The distal portion of the

protopodite is produced apically, directing the rami laterally. A trio of basipodal setae ornament the distal medial margin of the second segment of the protopodite. The endopodite is bimerous. The first segment bears three setae on the medial margin. The minute distal segment bears four setae disposed along the apical margin. Four long, stout, almost equal setae are arranged fan-wise across the outer margin of the exopodite.

The pentamerous maxilla preserves indications of further division of the basal segment. This proximal segment is complicated medially by the production of the margin as four setiferous lobes, presumably the counterparts of endites. The basal prominence bears three setae. The second prominence bears a single straight seta. The third endite bears two equal setae. The fourth endite is fairly well developed and bears two equal setae and an accessory setule. The second segment is produced medially as a heavy, tapered, curved, stout hook, bearing denticulations along the proximal edge. One seta is inserted basally on the hook-process accompanied by a minute setule. The succeeding two segments are very slender. On the distal medial corner of each is inserted a well-developed seta. The apical segment is much reduced. Its ornamentation consists of an apical trio of subequal setae.

The trimerous maxilliped is markedly slender and elongate. The basal segment bears eight setae arranged in two groups. Proximally, three setae are set close together along the margin. A quartet of setae is disposed around the distal medial corner and a large superficial seta is inserted near their bases. The second segment is rectangular, about a fourth again as long as wide. A single large seta is inserted at the distal medial corner. The distal segment is a truncated cone, its length 1½ times its greatest width. There are two setae inserted along the medial margin, and at the apex are inserted two long, subequal, plumose setae.

Swimming legs: The protopodite segments of the first legs are somewhat elongated. The intercoxal plate is slightly reduced. Inserted on the medial distal corner of the coxa is a slender seta which extends to the midpoint of the first segment of the endopodite. The basipodite is characterized by a very short lateral margin, near which is set a moderate-sized seta, and a much longer medial margin. At the distal medial corner of the basis is articulated a slender tapering spine which reaches to the distal margin of the first segment of the endopodite.

The rami are trimerous. The large basal segment of the exopodite bears a lateral spine and a well-developed medial seta. The second segment bears one much shorter, slighter lateral spine and a medial seta. The distal segment bears three lateral spines, an apical spine and seta, and three medial setae. The dimensions of the spines of the distal segment are varied. The proximal spine is very short. The

two next distal spines are slender but more elongate. The apical spine is slender and half again as long as the next longest spine.

The endopodite tapers somewhat from a distinctly thickened basal segment. The first two segments each bear a single medial seta. The terminal segment bears three medial setae, two apical setae, and a single seta inserted about midway on the lateral margin. Fine spinules form short rows ornamenting each of the segments of the endopodite and the basipodite near its medial spine, and produce a fine serration along the lateral margins of the segments of the exopodite.

The protopodites of the second legs are very long in proportion to width. The coxopodites are linked by a somewhat reduced intercoxal plate. At the distal medial corner of each coxa is inserted a slender seta. The only ornamentation of the basipodite is a reduced seta inserted near the short lateral margin.

The trimerous exopodite is slender and elongate. All the spinous elements of the armature are considerably setiform. Each of the two basal segments bears a lateral setiform spine and a medial seta. The distal segment bears three lateral setiform spines, graduated somewhat in length, two apical setae (the lateral one representing a spine), and four medial setae.

The endopodite is trimerous. The elongate third segment exhibits a most distinctive outline produced by strong medial emarginations into which the setae are inserted. The basal segment bears a single medial seta. The second segment bears two medial setae. The distal segment bears three medial setae, two apical setae, and a lateral seta inserted at the distal third.

The third legs are somewhat elongate and narrowed. The coxopodites are more or less rectangular and they are united by a reduced intercoxal plate. At the distal medial corner of the coxa is inserted a slender seta which does not quite reach the distal margin of the first segment of the endopodite. The armature of the basipodite consists of a single reduced seta inserted near the short lateral margin.

The basal segment of the trimerous exopodite is elongated. The second segment is slightly prolonged, subquadrate. The distal segment is elongate and tapered. All the elements of the armature are more or less setiform.

The basal segment bears a short, rigid, lateral, setiform spine and a medial seta. The second segment bears a lateral, elongate, setiform spine and a medial seta. The terminal segment bears three lateral setiform spines, two apical setae, and four medial setae.

The trimerous endopodite is elongate, mainly due to the pronounced extension of the distal segment, which is twice as long as the basal segment. All segments are relatively slender, the basal segment being a little longer than wide. The first segment bears a single medial seta.

The second segment bears two medial setae. The terminal segment bears three medial setae, two apical setae, and a lateral seta inserted at about the midpoint of the segment.

The protopodites of the fourth legs are elongate and slightly tapered to a somewhat conical aspect. The coxopodites are united by an intercoxal plate. At the distal medial corner of the coxa is inserted a small seta which extends just beyond the midpoint of the basal segment of the endopodite. Inserted near the very short lateral margin of the basipodite is a short, much-reduced seta.

All elements of the armature of the exopodite are setiform. The basal segment bears a short, lateral setiform spine and a medial seta. The second segment bears a lateral setiform spine and a medial seta. The terminal segment bears two lateral setiform spines, two apical setae, and four medial setae.

The trimerous endopodite is elongate. The basal segment is about as long as its greatest width and it bears a medial seta. The second segment bears two medial setae. The outline of the somewhat tapered third segment is characterized by emarginations accommodating the insertions of lateral and medial marginal setae. There are two medial setae, two apical setae, and one lateral seta.

Vestigial legs and caudal rami: The bimerous fifth legs are markedly elongate. The basal segment articulates along a diagonal line with the main mass of the body. There is a laterally inserted seta. The distal segment is half as wide as the basal segment, about 4½ times as long as wide, and exhibits a gradual distal taper. Inserted terminally on the distal segment are two unequal setae, one being half the length of the other. Along the distal half of the medial margin are set five or more curving rows of fine spinules, each row accommodated by a slight emargination of the integument.

The caudal rami are slightly over six times as long as their greatest width. They taper markedly but uniformly to the apex, which is half as wide as the base. Inserted on the apex are two long central setae, accompanied by one short lateral seta and a short medial seta. The longest seta is about two-thirds as long as the ramus. The short setae are between a third and a half of this length. Inserted on the lateral margin in a slight emargination at the proximal fourth is a short, slight seta. Another is set on the medial margin at its distal fourth. Ciliation of the setae of the ramus is reduced or obsolete.

Sars has provided an illustration of the male of this species. The outstanding feature of the sexual dimorphism is the possession of paired geniculate antennules. These are 10-segmented, with the articulation falling between the two terminal, much-elongate segments. The urosome of the male, including the somite of the fifth legs, is 6-segmented.

Remarks: Sars described the color of females of this species as uniform light reddish, with the eggs somewhat darker. Specimens from *Ascidia callosa* in Washington Sound were recorded as reddish orange.

The southernmost occurrence of this species in North America is not quite clearly established. Wilson (1935a) published a report of finding it in ascidians from California. Examination of specimens in the collections of the U. S. National Museum labeled to correspond with this record has not substantiated the identification. All the specimens so far found are other species of notodelphyids. Most specimens are assignable to the new genus *Pygodelphys*. It is possible, however, that the whole of the material examined by Wilson is not in the Museum collections.

Pygodelphys, new genus

Doropygus Schellenberg, 1922, pp. 238–241 (part).

Type species: *Pygodelphys aquilonaris*, new species.

Description and discussion of taxonomic characters: The differentiation of this genus from *Doropygus* was discussed under the latter. Four North American and Antarctic-Sub-Antarctic species form a coherent group which can best be treated by recognition of generic status. In many features *Pygodelphys* exhibits a transitional grade of structure between *Notodelphys* and *Doropygus*.

The body is compressed, with 5-segmented metasome and 5-segmented urosome. The fifth legs are borne on the metasome and the first urosomal segment is the genital somite. The caudal rami are of moderate size, well sclerotized, and bear relatively well-developed setae.

The antennule is intermediate between those of *Notodelphys* and *Doropygus*. Composed of nine or ten segments, it is long and the setation is profuse.

The antenna, mandible, maxillule, and maxilla much resemble those of *Notodelphys*, with close conformity of segmentation and ornamentation.

The maxilliped is much like that of *Doropygus*, distinctive in proportion, perhaps, but similar in basic structure. It is bimerous; the armature of the terminal segment is two robust plumose setae.

The swimming legs are highly characteristic. The first legs are most nearly generalized, with a well differentiated pattern of arrangement of spines. The posterior legs are elongate, with much modification of the armature, which is predominantly setiform. The endo-

podites tend toward coalescence of segments, accompanied by great prolongation. In most species the endopodites are flat lamellae.

The fifth legs are distinctive. They seem best derivable from the structure found in *Notodelphys*, but they are much reduced, consisting of two roughly equivalent setiferous lobes.

Sexual dimorphism of the appendages is less highly developed than in *Notodelphys*. It is comparable to the degree found in species of *Doropygus* having the most extreme differentiation.

Key to the species of *Pygodelphys*, based upon females

1*a*. Antennules with 9 segments. . . . . **novaeseelandiae** (p. 599)
1*b*. Antennules with 10 segments. 2
2*a*. Furca pointed apically, with stiff, saber-shaped terminal setae. **antarctica** (p. 599)
2*b*. Furca blunt apically, with spirally curled terminal setae 3
3*a*. Terminal 4 segments of antennule much elongate . . . **lamellipes** (p. 599)
3*b*. Seventh segment of antennule much elongate, 3 terminal segments subquadrate. . . . . **aquilonaris** (p. 600)

Species not known from North America

Pygodelphys antarctica (Schellenberg), new combination

Doropygus antarcticus Schellenberg, 1922, pp. 243, 264 (type localities: Falkland Islands; Tierra del Fuego, in *Paramolgula gigantea* (Cun.)).—Sewell, 1949, p. 174.

Distribution: Falkland Islands and Tierra del Fuego.
Host: *Paramolgula gigantea* (Cun.)

Pygodelphys lamellipes (Schellenberg), new combination

Doropygus lamellipes Schellenberg, 1922, pp. 242–243, 264, fig. 23 (type localities: Falkland Islands and Tierra del Fuego, in *Styela paessleri* Mchlsn.).—Sewell, 1949, p. 174.

Distribution: Falkland Islands and Tierra del Fuego.
Host: *Styela paessleri* Mchlsn.

Pygodelphys novaeseelandiae (Schellenberg), new combination

Doropygus novae seelandius Schellenberg, 1922, pp. 244–245, 264 (type locality, New Zealand, in *Pyura pulla* Sluit., *Paramolgula filholi* (Piz.), *Cnemidocarpa novae-seelandiae* Mchlsn.).
Doropygus novaesealandicus Sewell, 1949, p. 163.

Distribution: New Zealand.
Hosts: *Pyura pulla* Sluit., *Paramolgula filholi* (Piz.), *Cnemidocarpa novae-seelandiae* Mchlsn.

North American Species

Pygodelphys aquilonaris, new species

Figures 13, 14

Types: Holotypic female, USNM 92812 (type locality, Washington Sound, Wash., in *Pyura haustor* (Stimpson)); allotypic male, USNM 92813; paratypes, all specimens listed below.

Specimens examined:

Alaska
- From *Halocynthia aurantium*, (Pallas):
  - Unalaska Island, October 1878, L. M. Turner, 1 female, 1 male.

British Columbia
- From *Ascidia paratropa* (Huntsman):
  - Departure Bay, Jan. 20, 1931, G. H. Wailes, 1 female.

Washington
- From *Pyura haustor:*
  - Off Johns Island, July 5, 1939, dredged, types above.
  - Mitchell Bay, on floats, July 13, 1950, 1 female.
  - Indian Cove, Shaw Island, Aug. 18, 1948, dredged, 6 fms., R. L. Fernald, 6 specimens.
  - East of Upright Head, Lopez Island, June 23, 1950, dredged in 25–35 fms., 15 females.
  - Near Canoe Island, Off Shaw Island, July 1, 1950, dredged, 2 females.
  - Just north of east end of Lopez Pass, July 15, 1950, dredged, 3 females.
- From *Halocynthia aurantium:*
  - Near Friday Harbor, July 1950, from polyp of *Endocrypta huntsmani* (Fraser) in branchial cavity, 1 female.
- From *Styela gibbsii* (Stimpson):
  - Off Upright Head, Lopez Island, Aug. 2, 1949, R. L. Fernald, 4 females.
  - East of Upright Channel, June 23, 1950, dredged in 25–35 fms., 45 females.
  - Just north of outer end of Lopez Pass, July 15, 1950, dredged, 2 females.
- From *Cnemidocarpa finmarkiensis* (Kiaer):
  - Brown's Island, Friday Harbor, July 1, 1950, intertidal, R. L. Fernald, 10 plus specimens.
  - Outer end of Lopez Pass, July 15, 1950, dredged, 6 specimens.
  - Minnesota Reef, Turn Point, San Juan Island, July 16, 1950, intertidal, 1 female.
- From *Boltenia villosa* (Stimpson):
  - Obstruction Pass, Orcas Island, Aug. 18, 1948, dredged in 16 fms., R. L. Fernald, 11 specimens.
  - Upright Channel, San Juan Island, June 23, 1950, 10 females.
  - Just north of outer end of Lopez Pass, July 15, 1950, dredged, 5 females.
  - Upright Channel, July 19, 1950, dredged, 20 specimens.
- From *Chelyosoma productum* Stimpson:
  - East of Upright Channel, June 23, 1950, dredged in 25–35 fathoms, 3 females, 1 male.

Oregon
- From *S. gibbsii:*
  - Off Alseya River, Sept. 3, 1889, 116 fms., U. S. Fish Comm. Steamer *Albatross*, 3 females.

CALIFORNIA

From *Eugyra* sp.:

Corona del Mar, 1934, G. E. MacGinitie, 1 female.

In ascidian:

Corona del Mar, Aug. 1, 1933, 17 fms., G. E. MacGinitie, 2 females.

From *Molgula regularis* Ritter:

Scorpion Harbor, Santa Cruz Island, July 26, 1939, in 20 fms., W. G. Hewatt, 5 females.

DESCRIPTION: Female (figs. 13,*a–l*, 14,*m–s*): General features: The body (fig. 13,*a*) is compressed, with 5-segmented metasome and well-developed 5-segmented urosome. The metasomal components are the head, well-developed free thoracic somites of the first to third legs, and the large incubatory segment bearing the fourth and fifth legs. The first urosomal segment (fig. 13,*b*) is the thoracic genital somite. The remaining segments are abdominal. The head is produced ventrally at the apex into a stout rostrum.

Head appendages: The antennule (fig. 13,*c*) is 10-segmented. The two basal segments are much expanded and so articulated on the head and with each other as to provide a right-angled flexure. The third segment is much narrower than the second. The terminal seven segments are graduated in a fairly regular, slight taper. The terminal three segments are subquadrate in outline and the proximal two of these bear a distinctive ornamentation of fine spinules. Most of the remaining segments are slightly wider than long. Several segments are distinctive for the possession of one or more very long, basally stout setae. Two of these are inserted on each of the first two segments. Segments seven and ten bear one each. In addition, each segment bears a number of shorter, slender setae. The count of setae by segments is: 1–3; 2–10; 3–2; 4–3; 5–1; 6–2; 7–2; 8–2; 9–2; 10–7. The setae are plumose and of fairly stiff consistency.

The bimerous antenna (fig. 13,*d*) preserves only traces of the probable derivation by fusion of the two more proximal segments of the antenna of the type found in *Notodelphys*. Diagonal sulci in the integument at the distal sixth of the basal segment are related to the close-set insertions of two long, plumose, subequal setae. A short, reduced seta is inserted on the margin opposite to that bearing the two setae. The basal segment is five times as long as its greatest width. The second segment is nearly four times as long as wide and approximately three-fifths of the length of the basal segment. Terminally there is articulated a stout, tapered, curved claw. Six setae, of varying lengths, are inserted apically, close to the base of the claw. At about the distal fourth of the segment there is inserted a compact row of three graduated setae which lie closely appressed to the surface of the segment. Just proximal to these is set a short marginal seta.

FIGURE 13.—*Pygodelphys aquilonaris*, new species, female: *a*, habit, lateral view; *b*, urosome; *c*, antennule; *d*, antenna; *e*, masticatory lamella of mandible; *f*, palp of mandible; *g*, maxillule; *h*, maxilla; *i*, maxilliped; *j*, first leg; *k*, spine from segment 2 of first exopodite; *l*, apical spine from first exopodite. The scale, referring to *a*, represents 1.0 mm.

FIGURE 14.—*Pygodelphys aquilonaris*, new species. *m–s*, Female: *m*, second leg; *n*, third leg; *o*, fourth leg; *p*, terminal segment of fourth exopodite; *q*, fourth endopodite; *r*, fifth leg; *s*, caudal ramus. *t–w*, Male: *t*, antennule; *u*, fourth exopodite; *v*, fourth endopodite; *w*, somites of fifth and sixth legs, right side. *x* Female of variant from *Boltenia villosa* habit, lateral view. *y*, *z*, *aa–ee*, Variant aspects of distal segments of antennules of specimens from various hosts: *y*, from *Pyura haustor; z*, from *Boltenia villosa; aa*, from *Halocynthia aurantium; bb*, from *Ascidia paratropa; cc*, from *Cnemidocarpa finmarkiensis; dd*, from *Styela gibbsii; ee*, from *Molgula* sp.

At the proximal third of the segment is inserted another reduced marginal seta. Curving over the surface of the distal portion of the segment toward the margin opposite that with the setae are two rows of fine spinules.

The mandible is much like that of *Notodelphys*. The masticatory plate (fig. 13,*e*) of the coxa is ornamented along the medial edge by five principal tooth-like projections, a saw-edge of fine, close-spaced denticles, and two fine, seta-like members. The basipodite (fig. 13,*f*) is long and slender. At the distal fourth of the medial margin is inserted one well-developed seta. The endopodite is bimerous. The subquadrate basal segment bears four setae, arranged as a row around the distal medial corner. The margins of the terminal segment are parallel, the length is about 1⅓ times the width, which is about half the greatest width of the basal segment. Nine setae form a close-set row along the distal three-fourths of the medial margin and across the terminal border. The exopodite is elongate and tapering. The segmentation is obsolete, apparently reduced to a bimerous condition. Five very long subequal setae are disposed along the ramus.

The protopodite of the maxillule (fig. 13,*g*) is elongate and rather narrow. The segmentation is obscure or obsolete. A small lateral protuberance, doubtless representing the epipodite, furnishes insertion for a long, stout, proximally directed seta and a short accessory setule. Medially there are two projections probably representing endites. The proximal endite is a greatly developed, flaring prominence bearing a row of nine masticatory setae closely set along the medial margin. Just distal to this endite is the slight prominence of the second, produced distally as an elongate, tapering, setiform structure. The distal portion of the protopodite is produced apically, turning the rami laterally. A trio of basipodal setae ornament the distal medial margin of the protopodite. The endopodite is somewhat hand-shaped and bears five setae disposed along the apical margin. Four long, stout, almost equal setae are arranged fan-like across the outer margin of the exopodite.

The pentamerous maxilla (fig. 13,*h*) is stout and compact. The massive basal segment is complicated medially by the production of the margin as four setiferous lobes, presumably the counterparts of endites. The basal prominence bears four setae. One is a reduced setule, the remaining three are long and stout, somewhat curved, and their bases are close-set in a compact row. The second prominence bears a single long straight seta. The third endite bears two equal setae. The fourth endite is well developed as an almost articulated

extension from the main mass of the segment and bears two equal setae. The second segment is produced medially as a tapered, curved, stout hook, bearing denticulations along the proximal edge. Two setae are inserted basally on the hook-process, the dimensions of one nearly double those of the other. The succeeding two segments are very slender. On the distal medial corner of each is inserted a well-developed seta. The apical segment is much reduced. Its ornamentation consists of an apical trio of subequal setae.

The bimerous maxilliped (fig. 13,*i*) is markedly slender and elongate. The basal segment bears setae arranged in two groups. Proximally, three setae are set close together along the margin and a fourth is inserted on the surface close to them. A quartet of setae is disposed around the distal medial corner and a large superficial seta is inserted on the surface near their bases. The distal margin of this segment is diagonal, so that the distal segment, which is articulated at the far lateral margin, is markedly subapically inserted. The distal segment is a truncated cone, its length about twice its greatest width. At the apex are inserted two long, subequal, plumose setae.

Swimming legs: The protopodites of the first legs (fig. 13,*j*) are somewhat elongated and inflated. The intercoxal plate is slightly reduced. Inserted on the medial distal corner of the coxa is a long slender seta which extends just beyond the distal border of the second segment of the endopodite. The basipodite is characterized by a very short lateral margin, near which is set a short seta, and a much longer medial margin. At the distal medial corner of the basis is articulated a stout, tapering, slightly curved spine which reaches well beyond the distal margin of the first segment of the endopodite.

The rami are trimerous. The large basal segment of the exopodite bears a long, stout, lateral spine and a well-developed medial seta. The second segment bears one much shorter, slighter, lateral spine (fig. 13,*k*) and a medial seta. The distal segment bears three lateral spines, an apical spine (fig. 13,*l*) and seta, and three medial setae. The dimensions of the spines of the distal segment are varied. The proximal spine is very short. The two distal spines are slender but elongate. The three more proximal spines of the ramus are distinguished by the possession of thin, transparent, serrated, marginal flanges.

The endopodite tapers somewhat from a distinctly thickened basal segment. The first two segments each bear a single medial seta. The terminal segment bears three medial setae, two apical setae, and a single seta inserted about midway on the lateral margin. Fine spinules form short rows, which ornament each of the segments of the endopodite and the basipodite near its medial spine, and a fine serration along the lateral margin of the first segment of the exopodite.

The protopodites of the second legs (fig. 14,*m*) are very long in proportion to width. The coxae are linked by a much-reduced intercoxal plate. At the distal medial corner of each coxa is inserted a slender seta which reaches to the distal margin of the first segment of the endopodite. The only ornamentation of the basipodite is a reduced seta inserted near the short lateral margin.

The trimerous exopodite is slender and elongate. All the elements of the armature are setiform. Each of the two basal segments bears a lateral seta and a medial seta. The distal segment bears three lateral setae, graduated somewhat in length, two apical setae, and four medial setae.

The endopodite is bimerous. The elongate second segment exhibits a most distinctive outline produced by strong medial emarginations into which the setae are inserted. The basal segment bears a single medial seta. The distal segment bears five medial setae, two apical setae, and a lateral seta inserted at the distal third.

The third legs (fig. 14,*n*) are much elongate and narrowed. The coxopodites are more or less rectangular and they are united by a much-reduced intercoxal plate. At the distal medial corner of the coxa is inserted a slight seta which does not quite reach the distal margin of the first segment of the endopodite. The armature of the basipodite consists of a single reduced seta inserted near the short lateral margin.

The basal segment of the trimerous exopodite is much elongated, nearly equaling the combined lengths of the two distal segments. The second segment is slightly prolonged, subquadrate. The distal segment is elongate and slightly tapered. All the elements of the armature are setiform.

The basal segment bears a short rigid lateral seta and a short medial seta about twice as long. The second segment bears a lateral seta and a medial seta. The terminal segment bears three lateral setae, two apical setae, and four medial setae.

The bimerous endopodite is elongate, mainly due to the pronounced extension of the second segment, which is 2½ times as long as the basal segment. Both segments are relatively slender, the basal segment being about as long as wide. The first segment bears a single medial seta. The terminal segment bears five medial setae, two apical setae, and a lateral seta inserted at the distal fifth.

The protopodites of the fourth legs (fig. 14,*o*) are much elongate and slightly tapered to a somewhat conical aspect. The coxae are united at their basal third by a rudimentary intercoxal plate. At the distal medial corner of the coxa is inserted a small seta which extends

just beyond the midpoint of the basal segment of the endopodite. Inserted near the very short lateral margin of the basipodite is a short, much-reduced seta.

The basal segment of the elongate, trimerous exopodite approaches the combined lengths of the two distal segments, each of which is also markedly produced. All elements of the armature are setiform. The basal segment bears a short, lateral seta and a medial seta. The second segment bears a lateral seta and a medial seta. The terminal segment (fig. 14,*p*) bears two lateral setae, two apical setae, and four medial setae.

The bimerous endopodite (fig. 14,*q*) is markedly elongate, its apex reaching the level of the midpoint of the terminal segment of the exopodite. The basal segment is about as long as its greatest width and it bears a medial seta. The outline of the somewhat tapered second segment, which is 3½ times as long as the basal segment, is characterized by pronounced emarginations accommodating the insertions of lateral and medial marginal setae. There are four medial setae, two apical setae, and one lateral seta.

Vestigial legs and caudal rami: The fifth legs (fig. 14,*r*) are much reduced, with segmentation obsolete. Each consists essentially of a short plate with widely separated lateral and medial short prolongations. At the apex of each prolongation is inserted a short, slender seta. The lateral prominence is somewhat complicated basally, presenting slight evidence that it might represent the vestige of the distal segment characteristic of this appendage in most notodelphyids.

The caudal rami (fig. 14,*s*) are long, gently tapered, and somewhat flattened. The length is about five times the basal width. The integument of the rami is fairly heavily sclerotized. The armature is well developed. Three setae are inserted across the apex. Two of these are subequal and slightly exceed the length of the ramus. The third is half as long as these. Two setae are inserted in lateral emarginations. One, at the proximal fourth, is about three-fourths as long as the ramus. The other, at the distal fifth, is nearly as long as the ramus. A very short seta is inserted on the dorsal surface, toward the medial margin, at the distal eighth.

Male (fig. 14,*t–w*): The body is much smaller and slenderer than in the female. The metasome is 4-segmented. The urosome is 6-segmented. The caudal rami are slender and bear much more highly developed setae.

In the antennule (fig. 14,*t*) the terminal segments are coalesced and the second segment bears a short, stout hook-seta.

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The swimming legs are much more generalized than in the female. The armature of the posterior exopodites (fig. 14,*u*) includes well-developed spines.

The posterior endopodites (fig. 14,*v*) are trimerous and the segments are not nearly so elongate.

The fifth and sixth legs (fig. 14,*w*) are markedly similar in structure. In each, two setiferous lobes are borne at the end of the appropriate thoracic somite.

Remarks: This species shows a considerable range of variation, as might be expected of so widespread and tolerant a form. Several structural features seem constant for representatives from specific hosts. The variants are not considered sufficiently demarcated to warrant taxonomic designation at the present stage of knowledge of the group. The description above is drawn from the holotype, which is associated with *Pyura haustor*. This form is also that considered in drawing up the key to the species above. When the full range of variation of North American representatives is accounted for in a description, it is impossible to separate this from the very generalized published description of *P. lamellipes* (Schellenberg). However, since many specific details of the latter species have not received full treatment, it seems undesirable to give the northern specimens this specific name.

The variant types from Washington show a number of distinctive features. Specimens from *Boltenia villosa* (fig. 14,*x*) present a characteristic silhouette, due to posterior prolongation of the dorsal margins of thoracic somites to present the appearance of a series of spikes.

The terminal segments of the antennule vary in their proportions. The typical form from *Pyura haustor* has subquadrate terminal segments with spinulose ornamentation (fig. 14,*y*). Specimens from *Boltenia villosa* (fig. 14,*z*), *Halocynthia aurantium* (fig. 14,*aa*), *Ascidia paratropa* (fig. 14,*bb*), *Cnemidocarpa finmarkiensis* (fig. 14,*cc*), *Styela gibbsii* (fig. 14,*dd*), and *Molgula* sp. (fig. 14,*ee*) are figured to show the corresponding variations.

Genus *Pachypygus* Sars

Doropygus Thorell, 1859a, p. 52 (part).

Doropygus (*Notopterophorus*) Giesbrecht, 1882a, p. 294 (part).—Canu, 1892, p. 191.

Notopterophorus Schimkewitsch, 1893, p. 200 (part).—Schellenberg, 1922, p. 254.

Notopterophorus (*Doropygus*), Allen and Todd, 1902, p. 316 (part).

Pachypygus G. Sars, 1921, p. 51 (type species, by monotypy, *Doropygus gibber* Thorell, 1859).

This genus, proposed by G. Sars (1921), is well delimited but has retained its monotypic status to date. However, the American repre-

sentatives available have sufficiently characteristic features that it seems desirable at this time to emphasize the fact by proposing specific status for them. There is no outstanding distinction in setation, but there are sufficient minor deviations in detail to indicate a genetic separation. The diagnosis of the genus thus is not altered.

The body is invested with a heavily sclerotized integument which emphasizes the marked compression. The pentamerous metasome consists of a large cephalosome and four free thoracic somites, very unequal in size, with the first minute and the third much enlarged; a greatly expanded brood sack occupies most of the posteriormost segment. The urosome is 6-segmented and bears the somite of the fifth legs. The reduced perianal ring upon which the caudal rami are inserted is counted as the sixth segment.

The antennule is 7-segmented, with marked basal expansion. The setation of the trimerous antenna is much reduced. The endopodite of the mandible tends toward reduction, with accompanying diminution of the setae both in number and proportion. In the exopodite segmentation is suppressed so that the ramus becomes a rigid flat plate bearing well-developed setae.

The maxillule is characterized by the indistinctly bimerous endopodite, with profuse setation. The well-developed exopodite bears four strong setae. The second segment of the tetramerous maxilla bears an extremely heavy, prehensile claw-process. The setation of this appendage is relatively reduced. The maxilliped is trimerous, with all segments setiferous. The basal segment bears about eight setae, the second segment one seta, and the terminal segment four setae.

The swimming legs are marked by a strong tendency to reduction of setation. The first legs are not particularly distinctive, but in the succeeding three pairs the setae of the exopodites tend toward obsolescence or are absent. The fifth legs are generalized, and, except for their heavy sclerotization, conform well to the usual type found in *Doropygus*.

The caudal rami are highly sclerotized. They taper strongly from expanded bases. The terminal armature consists of a number of short, stout, curved claws rather than setae.

Key to the species of *Pachypygus*, based upon females

1*a*. Medial margin of third segment of fourth exopodite straight and unornamented . . . . **macer**, p. 610

1*b*. Medial margin of third segment of fourth exopodite sinuate, set with spinules . . . . **gibber**, p. 610

North American Species

?*Pachypygus gibber* (Thorell)

Doropygus gibber Thorell, 1859a, pp. 52–53, pl. 8, fig. 11 (type locality, Swedish coast, in *Ascidia intestinalis*); 1859b, pp. 339, 343; 1860, pp. 118–119, 123.—Hesse, 1866, pp. 63–64.—Buchholz, 1869, pp. 120–122, pl. 7, fig. 4.—Gerstaecker, 1870–1871, pp. 775–777, 792, 801.—Kerschner, 1879, pp. 186–187, pl. 1, figs. 5–7; pl. 2, fig. 6; pl. 3, figs. 2, 5–8; pl. 6, figs. 3–9.—Richiardi, 1880, p. 147.—Aurivillius, 1882a, p. 56, pl. 6, figs. 11, 12; 1882b, p. 112; 1883, pp. 26, 108, pl. 2, figs. 11, 12.—Koehler, 1890, pp. 137–138, fig. 10.—Canu, 1891, p. 472.—Thompson, 1893, p. 190, pl. 18, fig. 2.—Brian, 1898, p. 9.—T. Scott, 1900, p. 386; 1907, p. 364.—Graeffe, 1902, p. 39.—Stephensen, 1913, p. 349.—Chatton and Brément, 1915c, pp. 147–149, fig. 2.—Wilson, 1920, p. 14.—Gurney, 1933, p. 304.

Doropygus (*Notopterophorus*) *gibber*, Giesbrecht, 1882a, pp. 294, 317, 328.—Carus, 1885, p. 343.—Canu, 1892, pp. 191–193, pl. 5, figs. 25–31; pl. 6, figs. 1–8; pl. 7, figs. 1–10.—Pesta, 1909, pp. 258–262, pl. 1, figs. 1–6.

Notopterophorus gibber, Schimkewitsch, 1893, pp. 200–203; 1896, p. 339, pl. 14, figs. 33, 39–42, 47–52, pl. 16, figs. 53–55, 57–60.—Norman, 1905, p. 36.—Norman and Scott, 1906, p. 202.—Hartmeyer, 1911, p. 1735.—Schellenberg, 1922, pp. 254, 267.—Harant, 1931, p. 372.—Pesta, 1934, p. 8.—Sewell, 1949, p. 182.

Notopterophorus (*Doropygus*) *gibber*, Allen and Todd, 1902, pp. 316, 325.

Pachypygus gibber, G. Sars, 1921, pp. 51–52, pl. 25.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 120, fig. 71.—Lang, 1948, p. 3.—Sewell, 1949, pp. 182, 188.

Distribution: Mediterranean to Norway and Sweden; British Isles; (?)Greenland; (?)Australia.

Hosts: *Ascidia canina*, *A. glabra* Hartmr., *A. intestinalis*, *A. plebeia*, *A. venosa*, *Boltenia bolteni*, *Clavelina lepadiformis* Müll., *Clavellina* sp., *Cynthia microcosmus*, *Molgula ampulloides* Beneden, *M. oculata* Forb., *M. socialis* Alder, *Phallusia* cf. *cristata*, *P. fumigata* Grube, *P. obliqua*, *P. patula*, *P. virginea*, *Polycarpa comata* (Ald.), *P. gracilis* Hell.

Remarks: A report by Vanhöffen (1897, p. 292) of this species from Greenland has been shown by Hansen (1923, p. 26) to be based upon a misidentification of *Schizoproctus inflatus*. Whether Hansen's additional record of a specimen from Greenland is referable to this species or to *P. macer* will have to be decided by reference to the original specimen, if it can be located.

Pachypygus macer, new species

Figure 15

Pachypygus gibber, Wilson, 1927, p. 162.

Types: Holotypic female, USNM 92798 (type locality, Hurricane Harbor, Miami, Fla., in *Styela plicata* Lesueur), and paratypes listed below.

SPECIMENS EXAMINED:

FLORIDA
From *S. plicata:*
Hurricane Harbor, Miami, from test block, Mar. 23, 1950, L. B. Isham, holotype.
From solitary ascidian:
Gulf of Mexico, 3½ miles southwest of Longboat Pass, Sarasota Bay, Feb. 28, 1951, J. B. Knight, 1 female.
From *Microcosmus exasperatus* Heller:
Sanibel Island, Stewart Springer, 2 females.
SOUTH AMERICA
From *M. exasperatus:*
Spanish Water, Curaçao, 1920, C. J. van der Horst, 5 females.

DESCRIPTION: Female (fig. 15,*a–n*): General features: The body (fig. 15,*a*) is much compressed but with an inflated outline approaching an ovoid. This aspect is primarily that of the metasome, which much exceeds the urosome. The metasome is pentamerous, with a moderate sized head, a small thoracic segment bearing the first legs, a larger segment bearing the second legs, a much larger segment bearing third legs, and a much-expanded fourth segment which accommodates the brood sack. The urosome is 6-segmented and includes the somite of the fifth legs.

A well-developed rostrum protrudes anteriorly and ventrally between the bases of the antennules.

Head appendages: The antennule (fig. 15,*b*) is 9-segmented, with a complicated articulation at the ventral surface of the head. The proximal two segments are subequal, each is elongate and inflated, so that the combined length of the two considerably exceeds the combined length of the terminal seven segments. The second segment is longer than the first. At its distal border the ventral margin considerably projects beyond the base of the third segment producing the characteristic aspect of enveloping it. The width of the second segment at its distal margin is nearly twice the greatest width of the third segment. The third segment also presents the effect of slightly enveloping the base of the slightly narrower fourth segment. The seven terminal segments form a tapered assemblage, each in linear order slightly narrower than the preceding. The lengths are in approximately serial order also, except that the fifth segment is slightly longer than the fourth. The setae of the antennule are short and slender and the ciliation is diminished to lacking.

The antenna (fig. 15,*c*) is distinctly 3-segmented. The basal segment is the longest; the second segment the shortest. All segments are heavily sclerotized. The terminal hook is relatively long, slender and taperingly acuminate. The two proximal segments bear no setae. The terminal segment is ornamented with several short,

FIGURE 15.—*Pachypygus macer*, new species, female: *a*, habit, lateral view; *b*, antennule; *c*, antenna; *d*, masticatory lamella of mandible; *e*, palp of mandible; *f*, maxillule; *g*, maxilla; *h*, maxilliped; *i*, first leg; *j*, second leg; *k*, third leg; *l*, fourth leg; *m*, fifth leg; *n*, caudal rami. The scale, referring to *a*, represents 1.0 mm.

slender setae. Four setae are set near the articulating region of the terminal claw. A more proximal trio of setae is closely adherent to one of the flattened surfaces of the segment. Two isolated setae are more basally placed on the segment.

The mandible is well developed. The masticatory portion is illustrated (fig. 15,*d*). The palp (fig. 15,*e*) bears a complement of profusely plumose setae. The exopodite is a heavily sclerotized flattened plate with all evidence of segmentation suppressed. The five subequal, plumose setae are long and stout and arranged in a fan-like row on the lateral margin. The basipodite bears a long, stout, plumose seta inserted on the medial margin at a point about opposite to the lateral articulation of the exopodite. The terminal endopodite is 2-segmented. The basal segment is the shorter, but is the wider. It bears a medial row of four plumose setae, all well developed. The terminal segment bears a medial row of four setae, a medial distal pair of subequal setae, and a distolateral trio, consisting of two approximately equal, shorter setae, and a much stouter and longer seta at the lateral angle. All the setae are plumose.

The maxillule (fig. 15,*f*) has a well-developed protopodite, monomerous exopodite, and bimerous endopodite. The masticatory endite bears a medial row of about ten relatively short, stout, tapered setae. The next proximal endite supports a seta-like outgrowth of very much the same dimensions as the stoutest of the masticatory row of setae. The anatomically medial trio of setae of the basipodite are borne almost terminally on the appendage. The proximal seta of this group is much the longest and stoutest. The distal two setae are of about half the length and thickness of the accompanying seta. The endopodite is distinctly 2-segmented. The basal segment has a medial row of short, slender setae. There is a terminal trio of subequal longer, stouter setae on the very short distal segment. The exopodite widens sharply from a constricted articulation to a broadly truncate distal margin. Four subequal, long, stout setae are set along this margin. The epipodite supports a long, stout, tapering seta, accompanied by a very short, spike-like, plumose spinule or setule. All the setae of the appendage are plumose.

The maxilla (fig. 15,*g*) is 5-segmented. The terminal four segments are much inclined as a distal unit upon the much longer, stouter basal segment. The terminal three segments are slender and the fourth is much the longest of this distal trio. The setation of the appendage is generalized. The basal segment is ornamented by a basal quartet of setae set upon the prominent proximal protuberance. There are arranged successively a single seta and two couples of setae all borne on less conspicuous protuberances. The distal medial margin of the

second segment is much produced, flaring into the base of its heavy claw. The claw is accompanied by a long, plumose seta and a very short setule. The third segment supports a long, plumose seta at the distal medial corner. The armature of the fourth segment is a single distal, medial, long, plumose seta. The very short terminal segment bears four subequal setae, two of these seemingly terminal. The setae of the appendage are richly plumose.

The maxilliped (fig. 15,*h*) is 3-segmented. The basal segment is very long and slender. It bears medially a more basal quartet and a distal quintet of slender masticatory setae. The long, stout second segment bears one medial seta, relatively long and slender. The distal segment is the shortest and slenderest. It bears a medial row of three long setae and a distal, short, much-tapered seta. All the setae are plumose.

The first legs (fig. 15,*i*) are generalized. The intercoxal plate is tapering, with a resultant truncated triangular aspect. The medial coxal seta is long, reaching as far as the tip of the endopodite. The basipodite bears a lateral seta which approximately equals in length the basal segment of the exopodite. The medial spine of the basipodite is stout and tapered. It reaches about to the middle of the second segment of the endopodite. The spines of the exopodite are approximately serially graduated in length and of about the same stoutness. The exopodite is linear with little flexure of the segments upon one another. The two basal segments each bear a lateral spine and a medial seta. The distal segment bears three lateral spines, an apical spine and seta, and three medial setae.

The two proximal segments of the trimerous endopodite each bear a medial seta. The distal segment bears three medial setae, two apical setae, and a lateral seta.

The second legs (fig. 15,*j*) are modified. There is no intercoxal plate. There is a medium-long medial coxal seta. The lateral seta of the basipodite is short and slender. The endopodite is linear and the ornamentation is of generalized type. The exopodite is longer than the endopodite. It is flattened and fairly heavily sclerotized. Its spines have a characteristic short, straight, blunted aspect. Only the basal segment bears a seta, which is normally long and plumose. The basal segment also bears a heavy, short spine. The second segment bears only a similar spine. The third segment bears three short stout lateral spines and an apical spine about twice as long as the lateral members. The medial margins of the segments are linear and heavily sclerotized.

The ornamentation of the endopodite consists of one medial seta on the basal segment, two medial setae on the second segment, and

three medial setae, two apical setae, and one lateral seta on the distal segment.

The third legs (fig. 15,*k*) show the same trend of modification as do the second but with the more extreme aspect of complete lack of setae on the exopodite segments.

The two basal segments of the exopodite each bear a lateral spine. The distal segment bears three lateral spines and an apical spine. The medial margins of the two distal segments form almost a continuous, heavily sclerotized line.

The fourth legs (fig. 15,*l*) are also consistently specialized. The bimerous protopodite is expanded and inflated, with ornamentation obsolete.

The trimerous exopodite is conspicuously slender and elongate. It lacks setae entirely. The two basal segments bear each a stout lateral spine. The terminal segment bears three lateral spines and an apical spine. The medial margins of the segments are straight, uninterrupted, and heavily sclerotized.

The ornamentation of the trimerous endopodite consists of one medial seta on the basal segment; two medial setae on the second segment; and two medial setae, one apical seta, and two lateral setae on the distal segment.

The uniramous fifth legs (fig. 15,*m*) are heavily sclerotized. The long basal segment is relatively narrow and fairly markedly set off from the body somite. It bears a distal, medial, short, slender seta. The distal segment is about a quarter again as long as the basis. The armature is a medial distal seta and a thornlike spine toward the lateral corner. The lateral margin is indented with a characteristic sclerotized flange projecting distally beyond each point of indentation. The length of the segment is about 3½ times its greatest width.

The caudal rami (fig. 15,*n*) are very slender in proportion to their length, the ratio of greatest width to over-all length being 1:5. They exhibit a rather slight taper, further, with the basal width only about twice the apical width. The armature consists of four subequal, short spines, apically inserted, and a seta placed on the lateral margin three-fifths of the length of this margin from its base.

No male specimen has been found.

Remarks: This species is differentiated from *Pachypygus gibber* on the grounds of considerably less expanded development of various of the appendages. The body outline does not tend to so extreme a degree of exaggerated inflation. The urosome is a much slenderer cylinder with the middle segments tending to be somewhat longer than wide. The caudal rami are particularly slender in comparison with the older species.

The segments of the posterior swimming legs are much more produced in *P. macer*, and the inner margins of the terminal segments of the exopodites are linear and unornamented rather than sinuate and weakly spinose.

Pomphopygus, new genus

The genus is monotypic, with *Pomphopygus pinguis*, new species, described below, the type species. The specific description will also serve for the characterization of the genus, as it is so far known.

Pomphopygus pinguis, new species

FIGURE 16

TYPES: Holotypic female, USNM 92808 (type locality, Channel Islands, Calif., in *Ascidia clementea* Ritter), and paratypic females.

SPECIMENS EXAMINED:

CALIFORNIA

From *A. clementea:*

Off San Nicolas Island, dredged, 1904, U. S. Fish Commission Steamer *Albatross*, Station 5582, female types.

Off San Clemente Island, dredged in 659–704 fms., Apr. 9, 1904, U. S. Fish Commission Steamer *Albatross*, Station 4405, 1 female.

DESCRIPTION: Female (fig. 16,*a–p*): General features: The body (fig. 16,*a*) is much inflated with very lightly sclerotized integument. A fine fur of light ciliation covers most of the body. The general effect of the appearance in preserved specimens is that characterizing the hyperiid amphipods, combining transparency and sparseness of internal structure.

The metasome consists of a head complex, three free thoracic somites, and the greatly inflated incubatory segment.

The segmentation of the urosome has been impossible to establish accurately from the specimens available. The characteristics of texture mentioned above combined with the effects of poor preservation have brought about obscuring of surface texturing which would indicate the anatomical subdivisions. The caudal rami are unique among those of notodelphyids I have studied in their ballonlike quality. The usual slight degree of sclerotized rigidity here is seemingly lacking.

Head appendages: The 9-segmented antennule (fig. 16,*b*) is much like that in *Doropygus* but with reduced setation. The three basal segments form a fairly sharp taper. The six distal segments taper only gradually to the apex. The two most proximal segments are massive and much expanded. The distal portion of the third segment envelops nearly a half of the fourth segment. All the setae are

relatively weak and short. An approximation of the number present by segments is: 1–2; 2–5; 3–4; 4–3; 5–2; 6–3; 7–1; 8–1; 9–6.

The trimerous antenna (fig. 16,*c*) is stout with a weak terminal segment. The basal segment is longest, about twice as long as wide. The second segment is shortest. The third segment is markedly narrower than the second. It is about twice as long as wide; articulated at its apex is a weakly developed, curved, tapered prehensile claw. Four setae are inserted near the articulation of the claw. A very reduced seta is set at about the midpoint of the outer margin of the segment.

The mandible consists of a bimerous protopodite and two rami. The coxopodite is extended medially as a well-developed masticatory lamella (fig. 16,*d*). The serrations of the inner margin of the lamella are differentiated into five stout toothlike projections, a finely denticulate region, and two setiform processes. The basipodite (fig. 16,*e*) bears a single well-developed seta, inserted about midway on the medial margin.

The endopodite is bimerous; the first segment is much smaller than the second. A single seta is inserted on the medial margin of the basal segment. The distal segment bears six setae, three distributed along the medial margin, two apical, and one on the lateral margin. The setae are subequal and the longest and stoutest of them are still actually reduced.

The exopodite is a flattened, broadly ovate, platelike structure. The five nearly equal setae are all well developed, long and stout, and arranged nearly regularly around the outer circumference of the ramus.

The maxillule (fig. 16,*f*) is characterized by suppression of the rami and distal portion of the protopodite and exaggeration in bulk of the proximal portion of the protopodite. The single endite is greatly produced medially and bears along the inner margin six closely set, stout, stiff, masticatory setae. Inserted on the basal portion including this endite is the remainder of the appendage compressed to a palplike structure. Laterally at the base is borne a long, slender, proximally directed seta representing the epipodite. Just distal to this a projection bearing four equal setae represents the exopodite in which the articulation with the segment has been almost completely suppressed. An apical prominence bears three terminal setae and two medial setae. The anatomical explanation of this structure would assign the two medial setae to the basipodite and the three terminal setae to the endopodite with the articulation again having been suppressed to near obsolescence.

The tetramerous maxilla (fig. 16,*g*) is marked by great inflation proximally and some suppression of armature. The basal segment

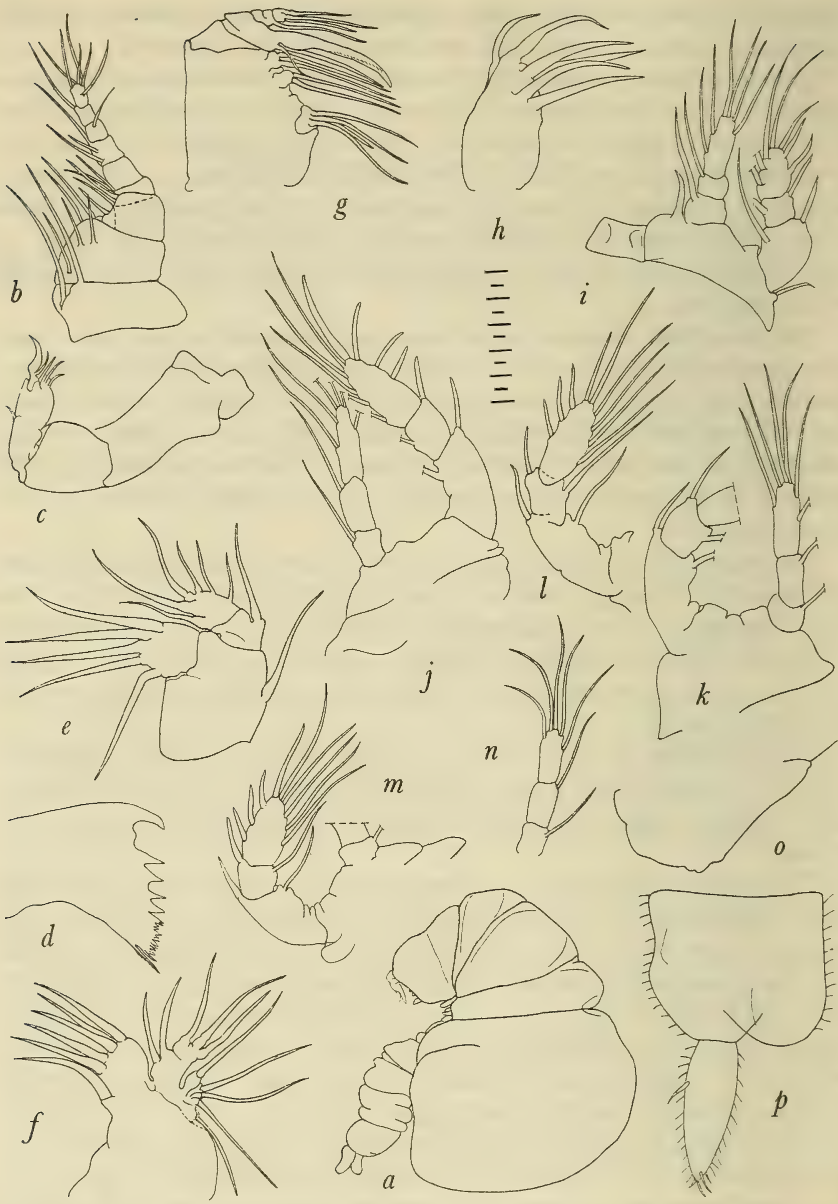

FIGURE 16.—*Pomphopygus pinguis*, new species, female: *a*, habit, lateral view; *b*, antennule; *c*, antenna; *d*, masticatory lamella of mandible; *e*, palp of mandible; *f*, maxillule; *g*, maxilla; *h*, maxilliped; *i*, first leg; *j*, second leg; *k*, protopodite and endopodite of third leg; *l*, third exopodite; *m*, protopodite and exopodite of fourth leg; *n*, fourth endopodite; *o*, fifth leg; *p*, caudal ramus. The scale, referring to *a*, represents 0.5 mm.

bears only three endites, the first one set with four setae and each of the two more distal ones bearing two approximately equal setae.

The second segment is well developed and produced medially as a very stout, heavily sclerotized hook or claw. Basally inserted on the claw-process is one equally long, well-developed seta and an accompanying reduced setule. The third segment bears a single seta inserted at the distal medial corner. The minute fourth segment bears three well-developed apical setae.

The maxilliped (fig. 16,*h*) is a reduced flattened plate with weakly sclerotized integument. Five fairly stout setae are grouped along the medial margin. A single seta is inserted at the distal lateral corner.

Swimming legs: The first legs (fig. 16,*i*) are composed of 2-segmented protopodites and trimerous rami. The coxopodites are yoked together by an intercoxal plate. The medial coxal seta of most notodelphyid genera is here absent. Inserted near the lateral margin of the basipodite is a short seta. Inserted distally and medially on the basipodite is a relatively stout spine which extends to near the distal margin of the second segment of the endopodite.

The basal segment of the exopodite is much the largest. It bears a lateral spine and medial seta. The second segment bears a lateral spine and medial seta. The distal segment bears two lateral spines, an apical spine and seta, and three medial setae, a distinctive ornamentation.

The two basal segments of the endopodite are short; their combined lengths are exceeded by that of the distal segment. Each of the two basal segments bears a single medial seta. The terminal segment bears two medial setae, two apical setae, and two lateral setae.

The setae of the rami are relatively short and slender and only feebly ciliated.

The second legs (fig. 16,*j*) are of small size and exhibit some reduction in structure. The bimerous protopodites lack armature and no intercoxal plate is present.

The exopodite is trimerous with the segments somewhat elongated in proportion to width. The basal segment, which is much the longest, and the second segment bear each a lateral spine and a medial seta. The third segment bears three lateral spines, an apical spine and seta, and four medial setae.

The endopodite is much smaller than the exopodite. The segments are progressively lengthened, so that the second is about twice as long as the first and the length of the third about equals the combined lengths of the two basal segments. The first and second segments bear each a medial seta. The third segment bears two medial setae, two apical setae, and two lateral setae. The setae of both rami are

short and slender and the usual plumose ciliation is here reduced or absent.

The somewhat reduced third legs (fig. 16,*k*,*l*) consist of bimerous protopodites and bimerous rami. Coxopodite and basipodite lack armature and there is no intercoxal plate.

The two proximal segments of the exopodite (fig. 16,*l*) bear each a lateral spine and medial seta. The terminal segment bears three lateral spines, an apical spine and seta, and four medial setae.

The endopodite is much smaller in bulk than the exopodite and slenderly linear in outline. The basal segment is much the smallest. The two subequal distal segments are each about twice as long as the basal segment. Each of the two proximal segments bears a single seta inserted at the distal medial corner. The distal segment bears two medial setae, two apical setae, and two lateral setae. All the setae of both rami are slender and with the usual plumose ciliation scant or absent.

The bimerous protopodites of the fourth legs (fig. 16,*m*) lack ornamentation and there is no intercoxal plate.

The two basal segments of the trimerous exopodite bear each a lateral spine and medial seta. The distal segment bears three equal lateral spines, an apical spine and seta, and four medial setae.

The trimerous endopodite (fig. 16,*n*) is slender and linear in outline and much exceeded in mass by the exopodite. The basal segment is much the shortest, equaling in length only about half that of either of the two subequal distal segments. The two proximal segments each bear a single seta inserted at the distal medial corner. The distal segment bears two medial setae, two apical setae, and a single lateral seta. None of the setae of the rami are ciliated.

Vestigial legs and caudal rami: The fifth legs (fig. 16,*o*) are reduced to thin scalelike plates lacking ornamentation.

The lengths of the caudal rami (fig. 16,*p*) are about three times the greatest width. The integument is very lightly sclerotized and distinguished by a profuse fine ciliation. Four subequal reduced setae are inserted at the apex. A fifth seta is inserted at the proximal third of the lateral margin.

No male specimen was found.

Remarks: The characteristics of this copepod do not permit its inclusion in any of the previously known genera. In many ways it appears to be a transitional form between the genera with less modified habitus, like *Doropygus*, and exaggeratedly specialized examples, like *Gunenotophorus*. The suppression of the palp portions of the mandible and maxillule bear out the resemblance to *Gunenotophorus*, as do the reduced maxillipeds. The swimming legs are somewhat like those in *Doropygus*, but they are considerably reduced. The absence of a

medial coxal seta on the first legs and the armature of the terminal segment of the first exopodite are features most rarely encountered among the notodelphyids. The degree of reduction of the fifth legs is also an unique feature among the series of forms in which this species seems to have its closest allies.

Genus *Gunenotophorus* Buchholz

Gunenotophorus (nomen nudum), Costa, 1840, p. 7.—Hope, 1851, p. 37.—Leuckart, 1859, p. 242.—Thorell, 1859a, p. 6; 1859b, p. 336; 1860, p. 115.—Claus, 1864, pp. 381–382.

Sphaeronotus Claus, 1864, p. 379 (not *Sphaeronotus* Laporte, 1832) (type species, by monotypy, *S. thorellii* Claus, 1864).

Gunentophorus Buchholz, 1869, p. 144 (type species, by monotypy, *G. globularis* Buchholz, 1869).—Gerstaecker, 1870–1871, p. 719.—Claus, 1875, p. 350.—Kerschner, 1879, p. 190.—Aurivillius, 1883, p. 26.—Carus, 1885, p. 344.—Brehm, 1927, p. 490.—G. Sars, 1921, pp. 56–57.—Wilson, 1924, p. 21; 1932, p. 602.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 121.—Lang, 1948, p. 3.—Sewell, 1949, p. 170.

Gynentophorus von Martens, 1879, p. 44.

Gunenotophorus Giesbrecht, 1882a, pp. 325, 326.—Canu, 1891, p. 475; 1892, p. 199.—Brian, 1905, p. 3; 1906, p. 144.—T. Scott, 1907, p. 366.—Stebbing, 1910, p. 550.—Schellenberg, 1922, pp. 257–258.

Gunentopherus Koehler, 1890, p. 138.

Gunenthophorus Graeffe, 1902, p. 40.

Gunetotrophus Norman, 1905, p. 36.

Guenenotophorus Harant, 1931, p. 371.

Doropygus Pearse, 1952, p. 189 (part).

The name *Gunenotophorus* was first published as an item in the specific catalog of Costa (1840, p. 7). This was a nomen nudum, and as such has been recorded by all the principal nomenclators. Accompanying this genus in the list was *Notopterophorus*, with two species, *N. elongatus* and *N. elatus*. These terms were also nomina nuda. In 1852 a set of plates illustrating entomostracans was published in Costa's same series and included as one of two designated "plate 2," a group of figures of copepods. There was no explanation of these figures ever issued. Not all sets of Costa's work include this plate. I have not been able to locate it in several sets consulted in the United States. However, several European authors refer to it. Among the figures are recognizable depictions of previously named species. For some of the remaining figures, authors have been unanimous in their acceptance that the illustrated features are recognizably attributable to the concept of a "notopterophorus." The figures left, by exclusion, are available as the illustration of the only unillustrated name on Costa's list, *Gunenotophorus globularis*.

Hope (1851) repeated Costa's listing of species, with the only additional information a mention of Sicily as the locality. Leuckart (1859) described a species of *Notopterophorus* and accepted Costa's

designation of the genus, referring to the list and to the figure. He also mentioned Costa's usage of *Gunenotophorus*, and stated that some of the figures of the plate perhaps refer to this name. Thorell (1859a, p. 6) referred to Costa, Hope, and Leuckart, and stated that Costa, on "plate 2," illustrated two crustaceans named *Gunenotophorus* and *Notopterophorus*. Thorell's statements were repeated in his references of 1859b and 1860.

Claus (1864, pp. 381–382), in his full description of *Sphaeronotus thorellii*, remarked that figures 1–3 of Costa would possibly apply to *Sphaeronotus*, in which case he assumed Costa's *Gunenotophorus* was the same as his genus.

Buchholz (1869) described and figured *Gunentophorus globularis*, attributing the authorship to Costa. Brian (1905, p. 3) described specimens from the Costa collections that came from Messina. It is possible that these were the animals upon which the original reference and figures were based.

It is clear that Costa's name was a nomen nudum and no one of the later workers, until Buchholz (1869), definitely established the connection of name, illustration, and organism. However, Claus' prior description of the species concerned as *Sphaeronotus thorellii* has precedence. Since *Sphaeronotus* Claus was preoccupied, the present genus is attributed to Buchholz (1869), emending his spelling.

The genus *Gunenotophorus* is a markedly coherent one, doubtless due to the small number of known forms. These are among the most massive of the notodelphyids, exhibiting a great inflation of the incubatory cavity.

The urosome is nearly normally developed, but the segmentation is partially obsolete. The caudal rami are so modified that seemingly they perform a prehensile function.

The head appendages are much specialized. The segmentation of the antennule is reduced and the structure is inflated. In most of the remaining head appendages the segmentation shows marked suppression and the ornamentation is variously reduced.

The first legs are unique in the expansions of the exopodites. The second to fourth swimming legs are also unlike those of any other notodelphyid. The exopodites are elongated and inflated, and the armature is obsolete to lacking. The endopodites are modified into members with no strictly comparable counterparts in other genera. Fifth legs are lacking. The male has not yet been described.

Schellenberg (1922) described a new species in the genus and also proposed a variety in *G. globularis*, var. *giganteus*. In view of the small amount of information generally available on anatomic variation in notodelphyids and of the distinctive character by which Schellenberg's variety is diagnosed, it is proposed to assign the form

specific status. By the addition of the new species described below, *Gunenotophorus* then includes four species, which may be separated in the following key.

Key to the species of *Gunenotophorus* based upon females

1*a*. Inner margin of terminal segment of second exopodite with row of prominent spines . . . . **spinipes** (p. 623)

1*b*. Inner margin of terminal segment of second exopodite without prominent spines 2

2*a*. Second exopodite thick and about one-third longer than second endopodite . . . . **giganteus** (p. 623)

2*b*. Second exopodite at least twice as long as the endopodite. 3

3*a*. Terminal segment of second exopodite straight . . . . **globularis** (p. 623)

3*b*. Terminal segment of second exopodite markedly curved . . **curvipes** (p. 629)

Species not Known from North America

Gunenotophorus giganteus Schellenberg

Gunenotophorus globularis Costa, var. *giganteus* Schellenberg, 1922, p. 258, fig. 39 (type locality, South Africa, in *Pyura stolonifera* (Hell.)).

Distribution: South Africa.
Host: *Pyura stolonifera* (Hell.).

Gunenotophorus spinipes Schellenberg

Gunenotophorus spinipes Schellenberg, 1922, pp. 258–259, fig. 40 (type locality, Straits of Magellan, in *Alloeocarpa emilionis* Michaelsen and *Polyzoa coccinea* (Cun.)).

Distribution: Straits of Magellan.
Hosts: *Alloeocarpa emilionis* Mchlsn. and *Polyzoa coccinea* (Cun.).

North American Species

Gunenotophorus globularis Buchholz

Figure 17,*a*

Gunenotophorus globularis (nomem nudum), Costa, 1840, p. 7.—Hope, 1851, p. 37.—Leuckart, 1859, p. 242.—Claus, 1864, pp. 381–382.

Sphaeronotus thorellii Claus, 1864, pp. 379–382, pl. 36, figs. 29–34 (type locality, Naples, in ascidians).

Gunentophorus globularis Buchholz, 1869, pp. 144–149, pl. 10, fig. 8 (type locality, Naples, in *Cynthia ?microcosmus*).—Kerschner, 1879, pp. 190–192, pl. 2, fig. 3, pl. 6, figs. 17–28.—Gerstaecker, 1870–1871, pp. 775, 804.—Aurivillius, 1882a, pp. 56–58; 1882b, pp. 70, 112, pl. 13, fig. 13; 1883, pp. 26–28, 66, 108, pl. 4, fig. 13.—Carus, 1885, p. 344.—Gourret, 1888, p. 1.—Koehler, 1890, pp. 137–138, fig. 11.—G. Sars, 1921, pp. 57–58, pl. 28, fig. 2.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 121, fig. 75.—Lang, 1948, p. 3.—Sewell, 1949, pp. 170, 176, 177, 182, 188, 191.

Gunenotophorus globularis Canu, 1891, p. 473; 1892, pp. 200–201, pl. 11, figs. 1–12.—Giesbrecht, 1892, p. 815.—T. Scott, 1900, pp. 387–388; 1901, p. 352; 1907, p. 366.—Brian, 1905, p. 3; 1906, p. 144.—Stebbing, 1910, p. 550.—Hartmeyer, 1911, pp. 1734–1735.—Schellenberg, 1922, pp. 258, 267–268, fig. 38.

Gunenthophorus globularis Graeffe, 1902, p. 40.

Gunetotrophus globularis Norman, 1905, p. 36.

Guenenotophorus globularis Harant, 1931, p. 371.

Doropygus robustus Pearse, 1952, pp. 189–191, figs. 2–8 (type locality, Alligator Harbor, Fla., in *Styela plicata* Lesueur).

Distribution: Mediterranean to Norway and Sweden; British Isles; South Africa; Gulf of Mexico (Florida).

Hosts: *Ascidia conchilega, A. prunum, Dendrodoa grossularia, Microcosmus microcosmus, M. sulcatus, Molgula ampulloides* (Bened.), *M. manhattensis, M. tuberifera, Pyura lurida* (?=*Cynthia lurida*), *P. mammillata, P. mentula, P. obliqua, P.* sp., *Polycarpa comata* Ald., *Polycarpa pomaria* Sav., *Styela coriacea, S. gyrosa, S. loveni* Sars, *S. rustica, Tethyum plicatum, S. plicata.*

Specimens examined:

Florida

From *S. plicata:*

Lemon Bay, Englewood, May 13, 1950, H. J. Humm, 48 females.

Description: Female (fig. 17,*a*): General features: The body (fig. 17,*a*) is 7-segmented, the greatest bulk being contributed by the much-inflated metasome, although the urosome is a markedly well-developed one. The head incorporates only the maxillipeds as a thoracic component. The lateral margins are produced as flaring epimera, which are directed somewhat ventrally. The segment of the first legs is free. The segments of the second to fourth swimming legs are tremendously inflated and incorporated in the ovoid brood sack which constitutes the bulk of the body.

The urosome is composed of four unequal segments, arranged as a gradually tapering cylinder. The first segment is the shortest and it bears the reproductive apertures. The second segment is as long as the succeeding two combined. The third segment is rectangular, about half again as long as wide. The terminal segment is of nearly the same proportions as the third but over-all is a slightly smaller somite. Articulated somewhat diagonally on the distal margin of the terminal segment are the laterally directed, somewhat dorsally curved caudal rami.

The front of the head is produced as a blunt, wedge-shaped rostrum with a very wide base.

Head appendages: The antennule is much inflated, particularly basally, so that it forms a short rounded cone. The segmentation is obscure but seemingly there are eight segments represented, these

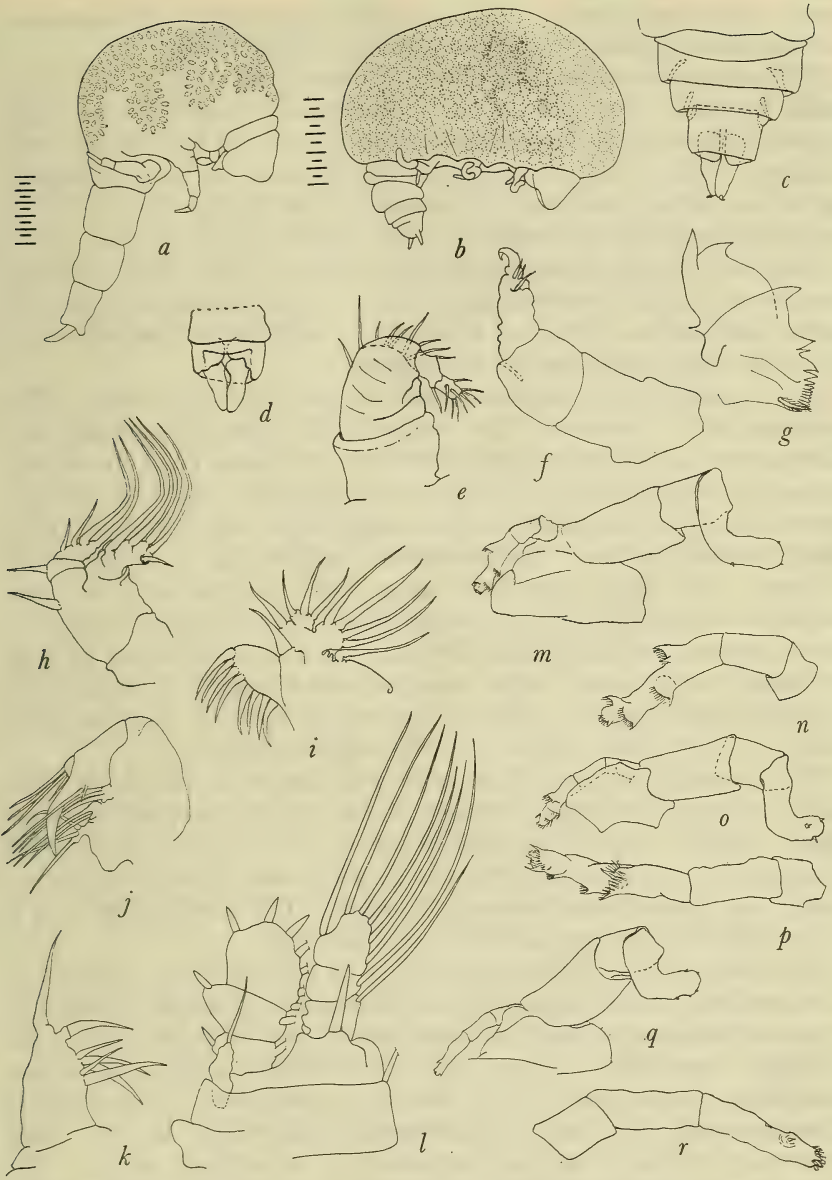

FIGURE 17.—*Gunenotophorus globularis* Buchholz and *G. curvipes*, new species. *a*, *G. globularis* Buchholz, female, habit, lateral view. *b–r*, *G. curvipes*, female: *b*, habit, lateral view; *c*, urosome; *d*, terminal segment of urosome and caudal rami; *e*, antennule; *f*, antenna; *g*, masticatory lamella of mandible; *h*, palp of mandible; *i*, maxillule; *j*, maxilla; *k*, maxilliped; *l*, first leg; *m*, second leg; *n*, second endopodite; *o*, third leg; *p*, third endopodite; *q*, fourth leg; *r*, fourth endopodite. The scale, referring to *a*, represents 1.0 mm., that referring to *b*, 1.0 mm.

much telescoped apically. The taper of the appendage is pronounced, so that the very small terminal segment is subquadrate.

The antenna is stout, stumpy, and heavily sclerotized. The two basal segments are nearly equal in dimension except for the slight proximal flare of the basal segment related to the articulation with the head. The terminal segment is slightly over half as wide basally as the second segment and is inserted on the middle portion of the terminal margin of that segment. The distal segment is about twice as long as wide and tapers gradually to a blunt apex. Here is articulated a short, stout, curved, tapered hook. Accompanying the hook is one short setule. Inserted at about the midpoint of the outer margin of the segment is another reduced seta.

The mandible exhibits considerable modification of the rami. The protopodite is bimerous. The coxopodite is expanded medially as a masticatory lamella, the margin of which is sculptured into five widely spaced, subequal teeth, a finely serrated region, and two setiform processes. The basipodite bears a single stout seta inserted on the distal medial corner. The bimerous endopodite is considerably reduced. The basal segment is short, with its ornamentation consisting of a distally inserted medial seta. The terminal segment is about a fourth narrower than the first and about half again as long. It bears five subequal setae arranged rather regularly around the roughly rounded apex. The most lateral of the setae may be much reduced to a minute setule or fairly well developed.

The exopodite is large, fairly wide, and somewhat flattened. The sides are roughly parallel, although the entire structure curves somewhat, and the apex is broadly truncate. Two setae are inserted along the medial margin at regular intervals and three more form a fairly wide-spaced array around the apex. The most lateral seta is about half the dimensions of the next smallest.

The protopodite of the maxillule is so oriented that the line of demarcation between basipodite and coxopodite portions is diagonal. A medially expanded basal endite supports a row of masticatory setae of varied dimensions. A second endite is represented by a blunt base furnishing insertion for a fairly stout, tapering seta. The epipodite is represented by a short protuberance upon which is set a long, proximally directed seta accompanied by a reduced setule. The basipodite is so oriented that the exopodite is directed entirely laterally and the appendage is terminated distally by a quadrate process bearing four short, regularly spaced setae. Some of these represent the usual basipodite setae and some the setae of the completely coalesced endopodite. The exopodite supports four well-developed setae inserted along the distal margin.

The trimerous maxilla consists of nearly normally developed proximal segments with the articulations of the terminal portion completely suppressed. The basal segment bears three medial endites. The first endite bears three setae arranged in a somewhat transverse row. The second endite bears two equal setae. The third endite bears two subequal setae accompanied by a minute setule. The second segment is well developed and supports a very heavy, short, curved claw. Basally inserted on the claw is a seta accompanied by a reduced setule. The third segment is nearly obsolete, affording insertion for just two apical setae, the terminal one of which is reduced to a third or less of the dimensions of the more nearly normal proximal seta.

The segmentation of the maxilliped is obsolete and the appendage is flattened, with a roughly conical outline. The ornamentation consists of seven variously developed setae arranged as a transversely inserted trio at about the midpoint of the distal margin, a more distal transversely inserted pair of setae, and two nearly equal apical setae. The lateralmost setae of the two more proximal groups are much reduced.

Swimming legs: The protopodites of the first legs are bimerous and the rami are trimerous. A well-developed intercoxal plate yokes together the coxopodites. There is no medial coxal seta. Laterally inserted on the basipodite is a seta with the proximal half much expanded into a stout cylinder. At the medial distal corner of the basipodite is inserted a slender, tapered spine which reaches almost to the distal margin of the basal segment of the endopodite. The segments of the exopodite are subequal. The basal segment bears a large medial seta and, inserted on the distal part of the lateral margin, a much-reduced, short spine. The armature of the second segment is similar. The terminal segment is ovoid with the longer axis more or less transverse. Four long, well-developed setae are regularly inserted along the medial margin. On the apex and at the distal fourth of the lateral margin are inserted two short spines.

The endopodite is rather little modified. The segments diminish regularly in width distally. The two basal segments are of about equivalent subrectangular proportions but the basal segment is about twice as large as the second. Each of the two proximal segments bears a large medial seta. The distal segment is roughly a short, blunt cone bearing five setae: two are inserted on the medial margin; one is apical; one is just subapical laterally; and the fifth is inserted on the lateral margin one-third of the length of the segment distal from the articulation.

The articulation of the bimerous protopodite of the second legs with the body is diagonal, so that the lateral margin of the coxopodite

is double the inner. The basipodite is small and with the lateral margin so reduced as to make it almost triangular in outline. There is no ornamentation borne on the segments of the protopodite. The exopodite is massively enlarged to several times the bulk of the endopodite.

The proximal segment of the trimerous endopodite is a large unornamented rectangle. The second segment is of similar proportions but of about half the absolute size. The third segment is slightly longer than the second, slightly narrower, and forms a tapered cone with semicircular apex. Six or more reduced spinules are irregularly set around the distal margins of the segment.

The endopodite consists of a subquadrate basal segment, a second segment about twice as long as the first, and a third segment equaling in length the proximal two combined. Three successive flares of the margins of the terminal segment confer on it a characteristic outline. Reduced spinules are inserted on the apexes of the flares.

The third legs are nearly identical in configuration with the second, with minor differences in proportion and details. The segments of the exopodite are absolutely slightly longer. The endopodite is somewhat larger. The second segment here is three times as large as the first. The sculpturing of the margins of the terminal segments is considerably reduced.

The aspect of the fourth legs is still further modified. The armature of the terminal segment of the exopodite is reduced to just two or three minute spinules. The endopodite is more distinctive. The basal segment is still quadrate, but the terminal portion is a single unit representing the coalescence of segments two and three. This distal unit is nearly five times as long as the basal segment. It tapers slightly apically and the sculpturing of the segments of the anterior limb is here represented only by slight undulations of the margins. There are two minute apical spinules.

Vestigial legs and caudal rami: Fifth legs are lacking.

The caudal rami are short, stout, and slightly tapered. The length is about two and a half times the basal width. The armature consists of three short, stout spinules, and a stout setiform element all inserted in an apical row.

The male has never been described.

Remarks: This species has been thoroughly illustrated in the works of Canu (1892) and G. Sars (1921), and the American specimens conform well to these presentations, with some slight modifications, as specifically detailed above. The specific name of Claus has priority. Since it has never been applied to this species by any author since its original proposition, it is regarded as preferable to continue here the use of *G. globularis* Buchholz. This is in accordance with

the developing sentiment in favor of conservation of names of long standing which has been expressed in recent deliberations on zoological nomenclature.

Gunenotophorus curvipes, new species

FIGURE 17,*b,r*

TYPES: Holotypic female, American Museum of Natural History Accession No. 6038 (type locality, Bering Strait, Alaska, in *Styela coriacea*). The other specimens examined are paratypes.

SPECIMENS EXAMINED:

ALASKA
 From *S. coriacea:*
  Bering Strait, July 1924, Capt. R. A. Bartlett, holotypic female.
 From ?*S. coriacea:*
  Exact locality unknown, 1930, 2 females.

DESCRIPTION: The outline of the body (fig. 17,*b*) approaches an uninterrupted ovoid, due to the marked inflation of the metasome and telescoping of the short segments of the urosome to reduce the obvious extent of the latter. The mass of the metasome represents the fused thoracic somites of the second to fourth legs, much inflated dorsally to form a brood cavity. The legs of each pair are well separated from each other by a wide midventral interruption, so that the appendages protrude laterally to give a mitelike appearance. The segment of the first legs is not obvious, and in the limited material available it has not been possible to determine if this somite is coalesced with the head or whether it is indistinguishably fused in the incubatory complex.

The urosome (fig. 17,*c*) is very short and stout. No segment is longer than wide and in the type specimen the segments are much telescoped. Similarly the terminal segment (fig. 17,*d*) envelops a considerable anterior portion of the caudal rami.

The rostrum is a well-developed anteroventral protuberance of the head.

Head appendages: The antennule (fig. 17,*e*) is modified, with segmentation suppressed and with a marked terminal taper. A considerable curvature obscures observation of the details, but it would seem that the appendage consists of four weakly setiferous, partially fused segments. The basal segment is large and seemingly unornamented. The second segment participates principally in the curvature. It bears a number of variously developed setae. The terminal segment probably involves fusion of two segments and it approaches the normal configuration found in other notodelphyids. It bears eight or more setae.

The trimerous antenna (fig. 17,*f*) is extremely stout, with a relatively weakly developed terminal segment. The basal segment is longest,

about half again as long as its greatest width. The second segment is massive, as wide as the first, somewhat wider than long, and with a relatively slight distal constriction. The distal segment is half as wide as the second and its length is roughly twice its width. Articulated terminally is a stout, tapered, markedly curved hook. Inserted at the base of the hook are two or three much-reduced setae. Another single seta is inserted a short distance proximal to this group.

The mandible consists of a bimerous protopodite and two rami. The coxopodite is extended medially as an unusually highly developed masticatory lamella (fig. 17,*g*). The serrations of the inner margin of the lamella are differentiated into several stout toothlike projections and a finely denticulate region. The basipodite (fig. 17,*h*) bears a single well-developed seta, inserted distally on the medial margin.

The endopodite is bimerous; the first segment is much smaller than the second. A single seta is inserted on the medial margin of the basal segment. The distal segment bears four setae, three distributed along the medial margin, one apical. The setae are subequal and the longest and stoutest of them are the two more apically placed.

The exopodite is much larger than the endopodite, stout, and somewhat tapered. Only traces of a fundamental segmentation are preserved. Four very stout, long setae are regularly spaced in a close-set row along the distal two-thirds of the medial margin. A much-reduced stub of a setule is inserted at the distolateral corner on the rather broadly truncate apex.

The maxillule (fig. 17,*i*) is characterized by suppression of the rami and distal portion of the protopodite and exaggeration in bulk of the proximal portion of the protopodite. The proximal endite is greatly produced medially and bears along the inner margin eight or nine closely set, stout, stiff masticatory setae. Inserted on the basal portion of this endite is a second process, bearing a single tapered setiform member. The remainder of the appendage is compressed to a palplike structure. Laterally at the base is borne a long, proximally directed seta representing the epipodite. Just distal to this a projection bearing four equal setae represents the exopodite in which the articulation with the segment has been considerably suppressed. An apical prominence bears three terminal setae and one medial seta. The anatomical explanation of this structure would assign the medial seta to the basipodite and the three terminal setae to the endopodite with the articulation again having been suppressed to near obsolescence, although faintly apparent.

The trimerous maxilla (fig. 17,*j*) is marked by great inflation proximally and some suppression of armature. The basal segment bears only three endites, the first one set with three setae, the next one set

with one seta, and the more distal one bearing two approximately equal setae.

The second segment is well developed and produced medially as a very stout, heavily sclerotized hook or claw. Basally inserted on the claw-process is one equally long, well-developed seta and a reduced setule. The reduced third segment bears three well-developed, subequal apical setae.

The maxilliped (fig. 17,*k*) is a reduced flattened plate with weakly sclerotized integument and suppressed segmentation. Five fairly stout setae are grouped along the medial margin. Two subequal setae are inserted apically.

Swimming legs: The first legs (fig. 17,*l*) consist of bimerous protopodites and trimerous rami. The coxopodites are yoked together by an intercoxal plate. Inserted on the medial distal corner of the coxopodite is a reduced seta which does not quite reach to the distal margin of the basipodite. Inserted at the lateral extent of the articulation of coxopodite and exopodite is a seta, of which the proximal half consists of a tremendously inflated base, and which is unusually long, extending to the proximal forth of the distal segment of the exopodite. A stout, tapered spine is articulated on the medial distal corner of the basipodite and extends well beyond the distal margin of the second segment of the endopodite.

The segments of the exopodite are much expanded and flattened, each somewhat constricted basally. Each of the two proximal segments bears laterally a short, stumpy spine. The armature of the distal segment consists of three similar spines regularly arranged around the broadly curving apex, and of four long, well-developed setae, disposed fairly evenly along the medial margin.

The basipodite is somewhat produced to articulate with the endopodite so that this ramus, although slightly shorter than the exopodite, actually extends a short distance beyond it. The two subequal basal segments bear each a long medial seta. The terminal segment bears three medial setae, two apical and subapical setae, and a lateral seta inserted in an emargination at about the midpoint of the segment.

In the second legs (fig. 17,*m*) the segmentation of the protopodites is obscured and the highly modified rami are trimerous. The protopodite is a massive protuberance upon which the rami are inserted. It lacks ornamentation. The mass of the exopodite is several times that of the endopodite. The articulations of the rami are such that they sprawl away from the central mass of the protopodite, the exopodite tending to take a lateral direction, the endopodite curling inward toward the midcentral line.

The two basal segments of the exopodite are roughly rectangular. The basal segment is about twice as long as wide. The second seg-

ment is more nearly subquadrate. Its width is two-thirds that of the basal segment. The length of the third segment is somewhat greater than that of the first segment and its width very little less than that of the second segment. The margins are parallel and the apex is a semicircle. A notable characteristic is the disposition of this segment in a 3-dimensional S-curve, the two loops of the curve arranged perpendicularly to each other. A few reduced spinules are inserted on the apical portion of the segment as the only ornamentation of the ramus.

The endopodite (fig. 17,*n*) consists of two small, rectangular proximal segments and a highly characteristic terminal segment. This segment is about three times as long as its basal width and features a series of elaborations of the integument. Each of these is a flare of the margin, terminating in a spinous projection and supporting a fringe of spinules. There are four of these, more or less alternated along the segment. A few spinules ornament the truncate apex. The segments are about equal in width except for the expansions of the terminal segment.

The third legs (fig. 17,*o*) conform very closely to the description of the second legs. The two distal segments of the endopodite (fig. 17,*p*) are proportionately somewhat longer than in the second legs.

The fourth legs (fig. 17,*q*) would also conform closely to the description of the second legs. The ornamentation of the exopodite is somewhat more profuse, consisting of six to eight small spinules. The endopodite (fig. 17,*r*) is slightly more distinctive. The two terminal segments are subequal and the elaboration of the distal segment is reduced. A spinule-like process is inserted subapically and the remainder of the ornamentation consists of a couple of spines and a row of fine spinules confined to the apex.

Vestigial legs and caudal rami: Fifth legs are lacking.

The caudal rami seem characteristically to be considerably enveloped anteriorly by the terminal segment of the abdomen. Each ramus is gradually tapered, its length about 2½ times its greatest width. The armature is obsolescent. The only element is a soft-textured, short, stout spine or seta inserted at the apex and seemingly retractile into a basal invagination.

No male has yet been found.

***Scolecodes*, new genus**

Scolecimorpha Henderson, 1931, p. 224 (part).

Type species: *Scolecimorpha huntsmani* Henderson, 1931.

At the time of the original description of the remarkable parasite more fully discussed below, it was assigned to the genus *Scolecimorpha* of G. Sars. Studies of additional specimens and reference to Sars'

description lead me to conclude the form is sufficiently distinct to warrant generic status. The absence of the labrum, a well-marked and highly characteristic feature of *Scolecimorpha*, the entirely different pattern of structure of the mouthparts, and the important feature in the body habitus of forming the brood sack to include one thoracic somite rather than four somites, seem justifiable grounds for this distinction. The original description by Henderson and the amplifications of detail provided below of the features of the single species will also provide the definition of the genus.

Scolecodes huntsmani (Henderson), new combination

FIGURE 18

Scolecimorpha huntsmani Henderson, 1931, pp. 217–224, figs. 1, 2 (type locality, Departure Bay, British Columbia, Canada, in *Styela gibbsii* (Stimpson)).

SPECIMENS EXAMINED:

WASHINGTON
From *S. gibbsii:*
Off Upright Head, Lopez Island, dredged, Aug. 2, 1948, R. L. Fernald, 2 females.
Upright Channel, dredged in 25–35 fms., June 23, 1950, 17 females.
From *Pyura haustor* (Stimpson):
Indian Cove, Shaw Island, dredged, Aug. 18, 1948, R. L. Fernald, 3 females.
East of Upright Head, dredged in 25–35 fms., June 23, 1950, 80 females.

DESCRIPTION: Female (fig. 18,*a–g*): General features: The body (fig. 18,*a*) is an elongate, tapered cylinder with a more or less distinctively marked off head and thoracic region and a sharply articulated urosome. The cephalothoracic region shows no segmentation. A few minor indentations probably are vestiges of the original metamerism. The head region forms an anterior triangle. Behind it are the rather close-set four pairs of swimming legs. The portion of the thorax posterior to the swimming legs is about twice as long as the anterior sector. The incubatory cavity occupies all of the portion of the body posterior to the swimming legs as far as the urosomal articulation. A specimen in the adult stadium, but with undeveloped incubatorium, is illustrated (fig. 18,*b*), on the same scale as the above, for comparison. The urosome is a single segment bearing the caudal rami. The segment is about as wide as long, with markedly convex margins, the basal and apical widths being approximately equal. The range of size among the available specimens is 5.2 to 14.6 mm.

Head appendages: In the original description the mouthparts were not described. They are particularly difficult to observe since they are minute and are crowded into a depressed area of the ventral surface of the head. Furthermore, the lateral margins of the head are flattened and expanded into flaps which fold ventrally and tend to enclose the mouth region. In a favorable whole mount of the animal

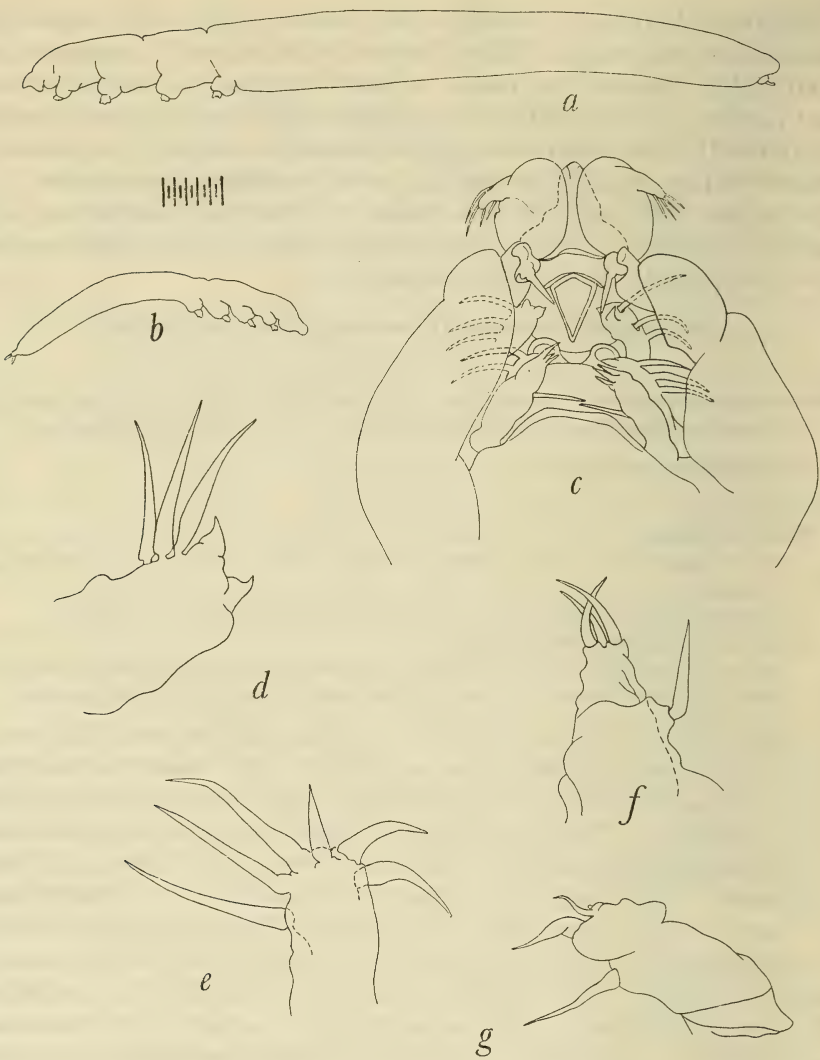

FIGURE 18.—*Scolecodes huntsmani* (Henderson), female: *a*, large ovigerous individual, habit; *b*, young adult female, nonovigerous; *c*, ventral view of head of female, illustrating the following head appendages, from anterior to posterior: antennules, antennae, first mouthparts, paragnaths, second mouthparts, third mouthparts; *d*, mouthpart of first pair; *e*, mouthpart of second pair; *f*, mouthpart of third pair; *g*, another view of mouthpart of third pair. The scale, referring to *a* and *b*, represents 1.0 mm.

it sometimes is possible to make out the mouth appendages (fig. 18,*c*). By tedious dissection most can be extricated for further detailed study.

The apex of the head is produced anteriorly and somewhat ventrally as an elongate, rather blunt rostrum with a wide base. The rostrum projects between the much-inflated bases of the antennules.

The antennule is bimerous. The basal segment is inflated to a nearly circular outline. The articulation of the second segment is not a sharp one. Apically is set a tuft of several setae.

The antenna might be considered as bimerous. The basal segment is considerably longer than wide. The distal unit consists preponderantly of the usual strongly prehensile hook, in this case with such a strongly expanded base as to suggest that this structure represents a reduced segment.

There is no conspicuously developed labrum or labium. The mouth opening is situated on a slight prominence and the mouthparts are arranged lateral and posterior to this.

The first pair of mouthparts (fig. 18,*d*) are roughly rectangular in outline. Two sharply acuminate, profusely ciliated prominences are set on the broadly truncate apex. Three long plumose setae are closely set distally on the lateral margin.

Posteriorly and medially to the bases of the first pair of mouthparts is set a pair of large paragnaths. These are long, inflated, and of roughly rectangular outline. The integument is so thin that all attempts to dissect them free from their site of insertion have failed. There is no armature (except for a fine ciliation) nor any indication of an articulation at the base.

The second pair of mouthparts (fig. 18,*e*) is very like the first pair. The outline is rectangular. At the center of the apex, on the distal medial corner, and far distally on the medial margin are set a close-spaced trio of markedly tapered, short, stout setae. These are profusely plumose. Equally heavily ciliated are three much longer setae inserted in a close-spaced row on the distal half of the lateral margin.

The complications of the integument of the third pair of mouthparts (fig. 18,*f*,*g*) suggest a partially suppressed bimerous condition. A long, stout plumose seta is inserted on the medial margin of the probable basal segment. On the truncated apex of the appendage are inserted three closely set, short setae.

Swimming legs: The four pairs of swimming legs are practically identical in construction. The protopodites are bimerous with a tendency to suppression of the segmentation, and the flattened rami are monomerous. The coxopodites are much inflated, knoblike protuberances. Reduced but distinctly observable intercoxal plates connect the members of each pair. The basipodite is of much smaller dimensions, furnishing little more than a common base for the insertion of the rami. There is no ornamentation of either segment of the protopodite.

The rami also are of practically identical construction throughout. The exopodite is a flattened ovoid plate with a widely transverse base and tapers to a rather narrow apex. The length is about half again

as great as the width. The whole external margin supports a compact row of short, stout spinules, usually eight or more in number. Apically and along the medial margin are set much larger, similarly proportioned spines, with bases adjacent, to the number of three to six.

Illustration and representative counts of the ornamentation of the limb series are presented in the original description of the species. These are representative as applying to the specific features of a given individual: First leg, exopodite, seven small lateral spines; three large terminal and medial spines; endopodite, eight small lateral spines, five large terminal and medial spines.

Second leg, exopodite, ten small lateral spines, six large apical and medial spines; endopodite, ten small lateral spines, six large apical and medial spines.

Third leg, exopodite, eleven small lateral spines, five large terminal and medial spines; endopodite, nine small lateral spines, six large terminal and medial spines.

Fourth leg, exopodite, eleven small lateral spines, four large terminal and medial spines; exopodite, ten small lateral spines, eight large terminal and medial spines. All the spines of this ramus show a tendency to form an irregularly double row.

Vestigial legs and caudal rami: Fifth legs are lacking.

The caudal rami are short, regular, markedly tapered, and terminally bear a row of four subequal setae. The length of the ramus is about 2½ times its basal width. The apical width is slightly more than half that at the base. The setae are about half again as long as the basal width.

No male has yet been found.

Remarks: The outstanding features of the biology of this copepod as it is so far known were discussed in the original description. All the specimens of the original lot were taken in association with *Styela gibbsii* (Stimpson). *Pyura haustor* (Stimpson), in the present findings, is recognized as an equally susceptible host. The association was noted in the first published notice of the species (Huntsman, 1912, p. 117) in which it simply was indicated as a parasite of the endostylar vessel in both known hosts. The tendency to multiple infection was noted by Henderson. In one specimen of *P. haustor* collected for the present study, 23 specimens of the copepod, of various sizes, were obtained from the endostylar vessel. No noticeable effect on the host of this massive invasion, other than the mere physical intrusion, was observed. The nauplius was described by Henderson. The smallest females taken are not ovigerous but they are identical anatomically with the largest.

The color of the examples here studied in life was a pale, semiopaque yellowish flesh color, with some pale orange markings. The eggs were white.

Pholeterides, new genus

The genus is monotypic, with *Pholeterides furtiva,* new species, described below, the type species. The specific description will also serve for the characterization of the genus, as it is so far known.

Pholeterides furtiva, new species

FIGURE 19

TYPES: Holotypic female, USNM 92809 (type locality, Washington Sound, Wash., in *Amaroucium californicum* Ritter and Forsyth), and paratypic females.

SPECIMENS EXAMINED:

WASHINGTON

From *A. californicum:*

West of Lopez Island, dredged, July 13, 1950, holotypic female and four female paratypes.

North of Upright Head, Lopez Island, dredged in 40 fms., Aug. 4, 1953, R. L. Fernald, 1 female.

DESCRIPTION: Female (fig. 19,*a–n*): General features: The body (fig. 19,*a*) is delimited sharply into a sausage-like metasome with segmentation obsolete and a markedly segmented urosome. The incubatorium occupies about half the mass of the metasome and extends from the level of the first swimming legs to the posterior margin of the tagma. There is no sign of segmentation of the metasome. The integument is thin and profusely haired. The head appendages are more or less vestigial and their placement is well anterior in the area corresponding to the mouth region. The first three pairs of swimming legs are fairly regularly spaced so that the third pair is inserted just slightly anterior to the midpoint of the metasome. The distance to the fourth pair of legs is somewhat more than double the interval between the preceding pairs. A fourth of the mass of the metasome extends posterior to the level of insertion of the fourth legs.

The urosome (fig. 19,*b*) is trimerous with apically inserted caudal rami of most distinctive aspect (fig. 19,*c*). The rami are mammiform, the length of each approximating about half the diameter of the expanded base. Each has a curved, acuminate apex, directed ventrally. The segment bearing the caudal rami is of about the same length but of slightly lesser diameter than the preceding segment. The first segment is twice as long as the combined second and third segments and slightly greater in diameter than the second somite.

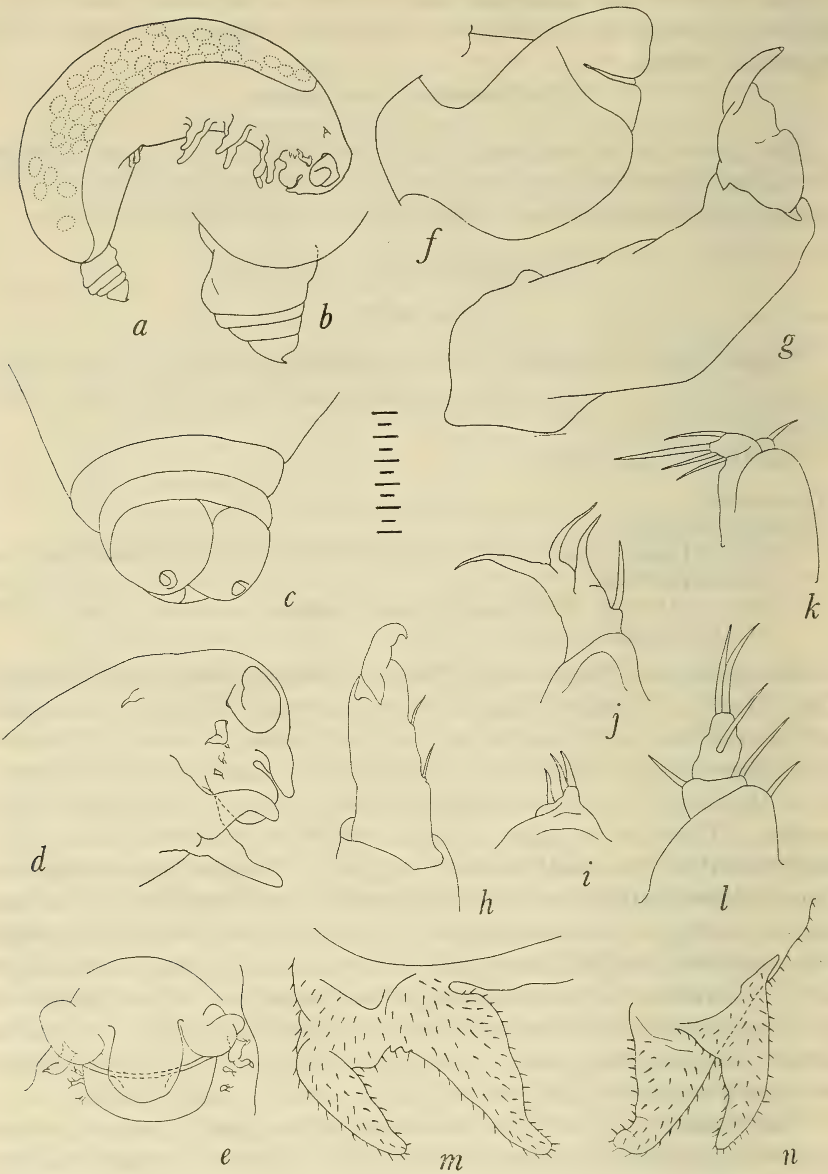

FIGURE 19.—*Pholeterides furtiva*, new species, female: *a*, habit, lateral view; *b*, urosome; *c*, caudal rami; *d*, head, lateral view; *e*, head, apical view; *f*, antennule; *g*, antenna; *h*, distal segment of antenna; *i*, mouthpart of first pair; *j*, mouthpart of second pair; *k*, mouthpart of third pair; *l*, another view of mouthpart of third pair; *m*, first leg; *n*, fourth leg. The scale, referring to *a*, represents 1.0 mm.

Head appendages: The most striking feature of the head is the complication of the oral region (fig. 19,*d,e*). I could find no mouth opening. At the expected level of the mouth an inflated cylinder curves transversely across the ventral side of the head. This structure must represent a much modified labrum or labium. Reaching posteriorly and ventrally to come in close approximation to this structure is the nearly equally inflated rostrum. All the head appendages are reduced and much displaced laterally, forming mere protruding lappets rather than elements of any obvious functional significance.

The antennules (fig. 19,*f*) are inserted laterally and curve outwards and upwards somewhat like ram horns. They are very wide at the base and taper rapidly to the curved apex. The segmentation is obsolete but indications seem to remain in sutures or sulci in the integument. There is no differentiated armature.

The bimerous antenna (fig. 19,*g*) preserves the greatest degree of indication of structural affinities with less aberrant notodelphyids. The proximal segment is long and slightly curved. It is unornamented. The length of the distal segment (fig. 19,*h*) is about twice its greatest width. It tapers to an articulation with a stout curved hook. Two reduced setae are inserted at about equal intervals on one of the margins.

The mouthparts are much reduced and anomalous. The presence of only three pairs, with no available distinguishing features, makes it impossible to homologize them with the usual notodelphyid appendages.

The most anterior pair of mouthparts (fig. 19,*i*) are reduced to small setiferous prominences situated far laterally on the head just caudal to the articulations of the antennae. Three close-set subequal setules constitute the armature.

The second pair of mouthparts (fig. 19,*j*) seem to be obscurely bimerous. The terminal portion bears four stout, much-tapered members of neither markedly spiniform nor setiform aspect.

The third pair of mouthparts (fig. 19,*k,l*) are the most complicated. They are seemingly trimerous, with enlarged basal portions. There is one seta inserted distally on the basal segment. The second segment is short and bears two setae, inserted oppositely on the segment. The terminal segment is about twice as long as wide and bears three setae.

Swimming legs: The segmentation of the biramous swimming legs is completely suppressed. The element on either side of any of the first three pairs (fig. 19,*m*) is a bilobed couple of elongate conical protuberances. They taper from a common base to narrowly rounded

apexes. There is no armature. The fourth pair (fig. 19,*n*) is still more reduced in proportions than the preceding pairs but can only be characterized as shorter, somewhat thicker protuberances.

Fifth legs are lacking.

The male of the species is not known.

REMARKS: Few details of the biology of this interesting species could be ascertained. The individuals all lie separately in small, cystlike cavities in the matrix of the ascidian, with no particular reference to the position of the tunicate zooids.

INDETERMINABLE GENERA

Genus *Salpicola* Richiardi

Salpicola Richiardi, 1880, p. 147 (type species, by monotypy, *Salpicola ialina* Richiardi, 1880).

Salpicola ialina Richiardi

Salpicola ialina Richiardi, 1880, p. 147 (type locality, Italian coast in *Salpa mucronata-democratica* Forsk).

Salpicola hyalina Carus, 1885, p. 43.

Genus *Ophioseidus* Bate

Ophioséide Hesse, 1864, pp. 354, 358 (type species, by monotypy, *Ophioséide cardiocéphale* Hesse, p. 354 (nomen nudum)).—Marschall, 1873, p. 415.—Scudder, 1882, p. 221.—Schulze, Kükenthal, and Heider, 1933, p. 2361.—Neave, 1939, vol. 3, p. 437.

Ophioseidus Bate, 1864, p. 309.—Schulze, Kükenthal, and Heider, 1933, p. 2361.

Ophioseides Gerstaecker, 1870–1871, p. 719.—Wilson, 1932, pp. 600–601.

This genus is here restricted to the following indeterminable species.

Ophioseidus cardiocephalus Bate

Ophioséide cardiocéphale Hesse, 1864, pp. 354–356, pl. 12, figs. 33–42 (type locality, northern coast of France, in "Botrylle" (nomen nudum)).—Giard, 1873, pp. 498–499.

Ophioseidus cardiocephalus Bate, 1864, p. 309.

Ophioseides cardiacephalus Gerstaecker, 1870–1871, pp. 774, 801.

Ophioseides cardiocephalus Chatton, 1909a, pp. 11, 18–19.—Hartmeyer, 1911, p. 1734.

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(New genera, species, etc., are printed in *italics*. Page numbers of principal entries also in *italics*)

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